

The Ascidians of the Reef Flats of Fiji

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This first account of the ascidians of Fiji is based on collections from the fringing reefs of Viti Levu, the island of Yakuve, and the Great Astrolabe Reef. Records confirm the wide range of the Indo-west Pacific ascidian fauna. Many species parameters are newly defined and scanning electron microscopy has contributed to the definition of species in the family Didemnidae that comprise half of the sixty species recorded. Five new species are described.

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INTRODUCTION

The collections on which this report is based are principally from the fringing reefs along the southern and eastern coasts of Viti Levu, the main island of Fiji, and from Yakuve and the Great Astrolabe Reef. Fiji has not previously been surveyed for this group of organisms. Most of the species recorded are from cryptic habitats under stones and boulders, and in crevices in the reef flat, but algal-bearing species (Kott, 1980) have been taken from the open reef flat. The cryptic species comprise a relatively small proportion of the reef flat ascidian biomass, being far outnumbered by the prolific algae-bearing didemnid species. Deeper subtidal habitats have not been sampled. The records confirm the wide geographical range of species in the tropical Indo-west Pacific (Kott, 1974, 1980) and only very few species are endemic to Fiji. For many of the species these records constitute the first since they were originally taken by the Siboga Expedition in 1900 (Sluiter, 1904, 1909).

This report refers only briefly to the 13 species of plant cell-bearing Didemnidae that occur prolifically in Fiji, but have been discussed more fully by Kott (1980). *Didemnum molle*, *Lissoclinum patellum*, *Trididemnum strigosum* and *T. nubilum* are newly recorded from Fiji.

There are five new species described. This does not necessarily reflect a high degree of endemism in the Fijian fauna. It is an indication of the extent to which the ascidian fauna of the Indo-west Pacific region is not understood and the parameters of species not defined. Scanning electron microscopy of spicules has contributed to the definition of species in the family Didemnidae, to which 34 of the 60 species recorded belong.

The following abbreviations are used in the account that follows: AMNH, American Museum of Natural History; BM, British Museum (Natural History); QM, Queensland Museum; ZMA, Zoological Museum of Amsterdam. Where colours of the living specimens have been matched with standards from Ridgeway (1886) they are stated in quotation marks.

SYSTEMATIC DESCRIPTIONS

Order APLOUSOBRANCHIA

Family HOLOZOIDAE

Distaplia vallii Herdman, 1886

Figs 1-3

Distaplia vallii Herdman, 1886, p. 128.*Holozoa vallii*: Van Name, 1918, p. 140.? *Leptobotrylloides dubium* Oka, 1927, p. 607.? *Distaplia dubia*: Tokioka, 1953a, p. 206; 1954b, p. 82.? *Distaplia japonica* Tokioka, 1951, p. 169.**Distribution***New Records*: Fiji — Viti Levu: Malevu, July 1979, LWM, QM G12578; Tai Levu, July 1979, LWM, QM G12591.*Previously Recorded*: Morocco — Herdman, 1886. Philippines — Herdman, 1886; Van Name, 1918. ?Japan (Honshu) — Oka, 1927; Tokioka, 1951, 1953a, 1954b.*Depth range*: 0-64.4 m.**Description***Colony*: The living colonies are two-toned, purple and pinkish-mauve. In preservative they are blue with white zooids, greyish green, or rose coloured. The specimens in this collection are flattened cushions with 3 to 10 round to oval systems of up to 15 zooids. The test is fibrous and spongy.*Zooids*: The distapliid thorax, with its wide atrial aperture produced into a large muscular languet, has conspicuous longitudinal muscles, some of which break into small branches across the endostyle, and some extend into the short 6-lobed branchial siphon. There are 4 rows of 25 stigmata, each row crossed by a fine parastigmatic vessel. The abdomen is relatively small with fine longitudinal gastric folds. There is a group of small ♂ follicles in the gut loop. There is a large gastro-intestinal reservoir in the loop of the gut.*Larvae*: Single larvae are present in the brood pouch of the specimens from Malevu. They are large, 1.6 mm long. The larval test appears spongy as in the adult colony. This is due to large slightly irregular vesicles which, in the preserved material, are blue or green and sometimes appear to contain darker granules. These obscure the developing embryo.

The larva has the usual 3 triradiate adhesive organs with short thick stalks, swollen into paired rounded prominences at the base of each epidermal cup. These stalks arise from the thick frontal stalk of the embryo. The oozoid is large, occupying the central part of the larval trunk and there is a relatively extensive portion of the larval trunk posterior to the developing oozoid.

Remarks: Herdman's specimens from the Philippines, and from the Mediterranean are distinctly stalked, while the present specimens are sessile cushions, fixed by the whole extent of their flattened base. Other specimens from the Philippines 'exhibit great variation in the form of the colony ranging from distinctly capitate colonies raised on a short but more or less distinct neck, to irregular rounded masses and even flattened incrusting forms' (Van Name, 1918, p. 140). The test in these specimens is spongy and fibrous as in the present colonies. This condition of the test, however, is found in other species of this genus. Species recorded from Japanese waters, *D. dubia* (Oka, 1927) (see Tokioka, 1967), *D. coronata* Tokioka, 1955a, *D. systematica* Tokioka, 1958 and *D. miyose* Tokioka, 1962, are closely related. They all have a similarly spongy test, parastigmatic vessels, gonads contained in the abdomen rather than in a posterior abdominal extension and fine longitudinal folds in the stomach. *Distaplia coronata*, *D. systematica* and *D. miyose* have only one system in each cormidium. Variations in the orientation of thoracic musculature (which Tokioka has primarily used to distinguish the species) may only be apparent and result from

differences in contraction. The colour of these formalin-preserved colonies is greyish green as are some of the present colonies. The larva of *D. coronata* is known and is identical with those of the present specimens, with a similarly spongy test. It is possible that these species are synonymous with *D. dubia*, which has a similar range in Japanese waters, and includes capitate specimens with single systems (see Tokioka, 1953a)



Figs 1-7. 1-3, *Distaplia vallii* (QM G12578) : 1, colony from the upper surface showing distribution of zooids around common cloacal aperture. 2, zooid. 3 — a, larva; b, larval pigment cells. 4, *Eudistoma discederata* n. sp. (QM G12583) : a, colony; zooid. 5, 6, *Eudistoma rubra* (QM GH40) : 5, anterior end of zooid. 6, larva. 7, *Eudistoma rigida* (QM GH62), larva.

Distaplia dubia displays the same range in colony form and pigmentation as the present specimens and no characteristic is known that can be used to distinguish these highly variable species.

Family POLYCITORIDAE

Eudistoma discederata n. sp.

Fig. 4

Distribution

Type Location: Fiji — Viti Levu: Laucala Bay, experimental mussel raft, with *Symplegma viride*, July 1979, Holotype, QM G12583; Sand Bank Reef, underside of rubble side of channel, July 1980, Paratype, QM GH46.

Description

Colony: The colony is very irregular and only 6 mm thick. There is a spreading basal mass, about 1 cm in maximum extent. The thoraces, each encased in its own separate layer of test, arise densely from the surface of the basal mass of the colony. The test is transparent, gelatinous and soft.

Zooids: These are characteristic of the genus, with 6 rounded lobes fringing each of the apertures. The thorax and abdomen are of approximately equal length. About 12 longitudinal thoracic muscles extend along the length of the thorax and continue in a band on either side of the abdomen. The transverse thoracic musculature is well spaced. There are 3 rows of 6 long rectangular stigmata.

The short stomach is in the posterior third of the abdomen. Gonads of the usual form are present in the loop of the gut, with a large one-egg ovary to the right of the ♂ follicles.

Larvae: Up to 5 embryos present in the peribranchial cavity. Well-developed larvae are 0.4 mm long, with a large ocellus and an otolith, 3 median adhesive organs, 4 pairs of ectodermal ampullae and the tail wound three-quarters of the distance around the trunk.

Remarks: This is the first known species of this genus in which the thoraces are free of the common test. It is unlikely that it is a primitive character, indicating any affinity with species in the family Clavelinidae (in which partial separation of the zooids often occurs). The zooid is characteristic of the genus *Eudistoma* and displays no unique characters except the small number of stigmata in each row. The larvae are especially small but otherwise quite characteristic of the genus.

Eudistoma rubra Tokioka, 1954

Figs 5, 6

Eudistoma rubra Tokioka, 1954, p. 252; 1967, p. 117.

Distribution

New Records: Fiji — Viti Levu: Mumbualau, reef flat close inshore at the base of shallow crevices in surface of the reef below LWM, July 1980, QM GH40.

Previously Recorded: Japan (Tokara Is.) — Tokioka, 1954a. Gilbert Is. — Tokioka, 1967.

Description

Colony: Rounded translucent heads are supported on short thick stalks (about 1.5 cm long and up to 2 cm in diameter) that arise from a thick basal mat. In the living specimens the heads are expanded and the separation between adjacent heads is not apparent to the naked eye so that the colony appears to be a large hemispherical mass (up to 6 cm diameter), translucent and pale cloudy pink. The orange colour in the musculature of the zooids is diffused by the cloudy translucent test to create the

apparent pink colour of the colony. In preservative the head collapses to little more than the diameter of the stalk. The zooids lie parallel to one another in the preserved material, but in life they diverge anteriorly to open all over the surface of the colony. The basal test contains oval faecal pellets.

Zooids: The zooids are long (up to 3 cm when expanded) and very thin. The thorax is only about one quarter of the length of the long, narrow abdomen. They are not arranged in systems. The apertures have 6 well-developed pointed lobes and the anterior lobe of the atrial aperture is often enlarged. Longitudinal muscles extend along the centre of each lobe to its pointed tip. There are circular sphincter muscles around each short siphon. Fifteen longitudinal muscle bands on the thorax lie superficial to a continuous coat of fine circular muscles. The longitudinal muscles extend in wide bands along both sides of the abdomen. There are 3 rows of stigmata. In the second and third rows there are 10 stigmata. In the anterior row, an additional 6 stigmata extend anteriorly, oriented at an angle to the mid-dorsal line (see Tokioka, 1954a, p. 253, fig. 2). The oesophagus is very long, expanding to the oval, smooth stomach in the posterior one third of the abdomen.

Larvae: There are up to 2 (never more) larvae in the peribranchial cavity. The trunk is 0.7 mm long. The anterior border of the trunk is produced into solid, dorso-ventrally flattened pad-like ampullae, 2 between adjacent adhesive organs. In one larva the central adhesive organ appears to have subdivided, the duplicate extending between the dorsal pair of pads. The stalked adhesive organs contain a small central mass of adhesive cells and a circular epidermal cup. There is an otolith and an ocellus.

Remarks: The specimens conform exactly to Tokioka's (1954a) description in all respects except for the coat of circular muscles that is present in these specimens. The colour and form of the colonies, the longitudinal musculature, the number of brooded embryos and the characteristic additional stigmata in the anterior row are identical. The larvae in the present specimens are better developed than Tokioka's and this may be the reason for their larger size. The larva is similar to that of *Eudistoma elongata* from eastern Australia (Kott, 1957b).

Eudistoma arenacea (Sluiter, 1909)

Polycitor arenaceus Sluiter, 1909, p. 13.

?*Eudistoma arenosum* Kott, 1957b, p. 73.

Distribution

New Records: Fiji — Viti Levu: Sandbank Reef, LWM June 1980, QM GH87; Mumbualau, LWM July 1980, QM GH89.

Previously Recorded: ?Western Australia (Rottneest Is.) — Kott, 1957b. Indonesia — Sluiter, 1909.

Description

Colony: The colonies are oval, soft and sandy cushions about 2 cm long and up to 0.5 cm thick. The test is glassy but filled with sand and faecal pellets in moderate density. Some, but not all of the zooids are arranged in circular systems.

Zooids: The atrial siphon is longer than the branchial siphon. The circular sphincter muscle is only moderately developed on both siphons. There are 15 longitudinal muscles on the thorax extending along both sides of the abdomen and a continuous coat of circular muscles. The three rows of stigmata each have 20 stigmata. The oesophagus is long, the stomach in the posterior third of the abdomen.

Larvae: Larvae were not present in these specimens.

Remarks: The species is distinguished from *E. pyriforme* and *E. ovatum*, both sand-containing tropical species of *Eudistoma*, by the straight gut loop, without twists or

loops (see Hastings, 1931). There are no particular characteristics of either the zooid or the colony except the tendency to form systems.

Eudistoma rigida Tokioka, 1955

Fig. 7

Eudistoma rigida Tokioka, 1955b, p. 50.

Distribution

New Records: Fiji — Viti Levu: Makaluva, LWM July 1980, QM GH62; Sandbank Reef (Laucala Bay), LWM July 1980, QM GH100.

Previously Recorded: Palau Is. — Tokioka, 1955b.

Description

Colony: The colonies form smooth fleshy cushions up to 4 cm in maximum extent and 1 cm thick. In preservative they are dark grey, owing to clouds of minute black pigment cells in the surface test. These become less dense toward the base of the colony. Zooids are white. They are arranged in circles with the atrial openings in an inner concentric circle. There are some oval faecal pellets and some sand scattered sparsely in the test. The colour of the living colony from Fiji has not been recorded. Specimens from the Great Barrier Reef (Heron Is.) are yellow, orange, or green and yellow.

Zooids: The contracted zooids are about 2 mm long. The branchial and atrial lobes are conspicuous and rounded. The atrial siphon is long and muscular. About 20 longitudinal thoracic muscles continue onto the abdomen where they extend in one wide band along each side. There are 15 stigmata in each of the three rows. The abdomen is much contracted in these specimens.

Larvae: There are two large larvae in the peribranchial cavity. The larval trunk is 0.6 mm long and the tail is wound half way around it. There is an otolith and ocellus. Three adhesive organs in the mid-line are separated by wide median ampullae.

Remarks: In the preserved material the dense grey colour of the surface layers of test, shading to translucent light grey, together with the circular arrangement of the zooids and the virtual absence of sand in these fleshy colonies are characteristic.

Eudistoma vitiata n. sp.

Figs 8, 9

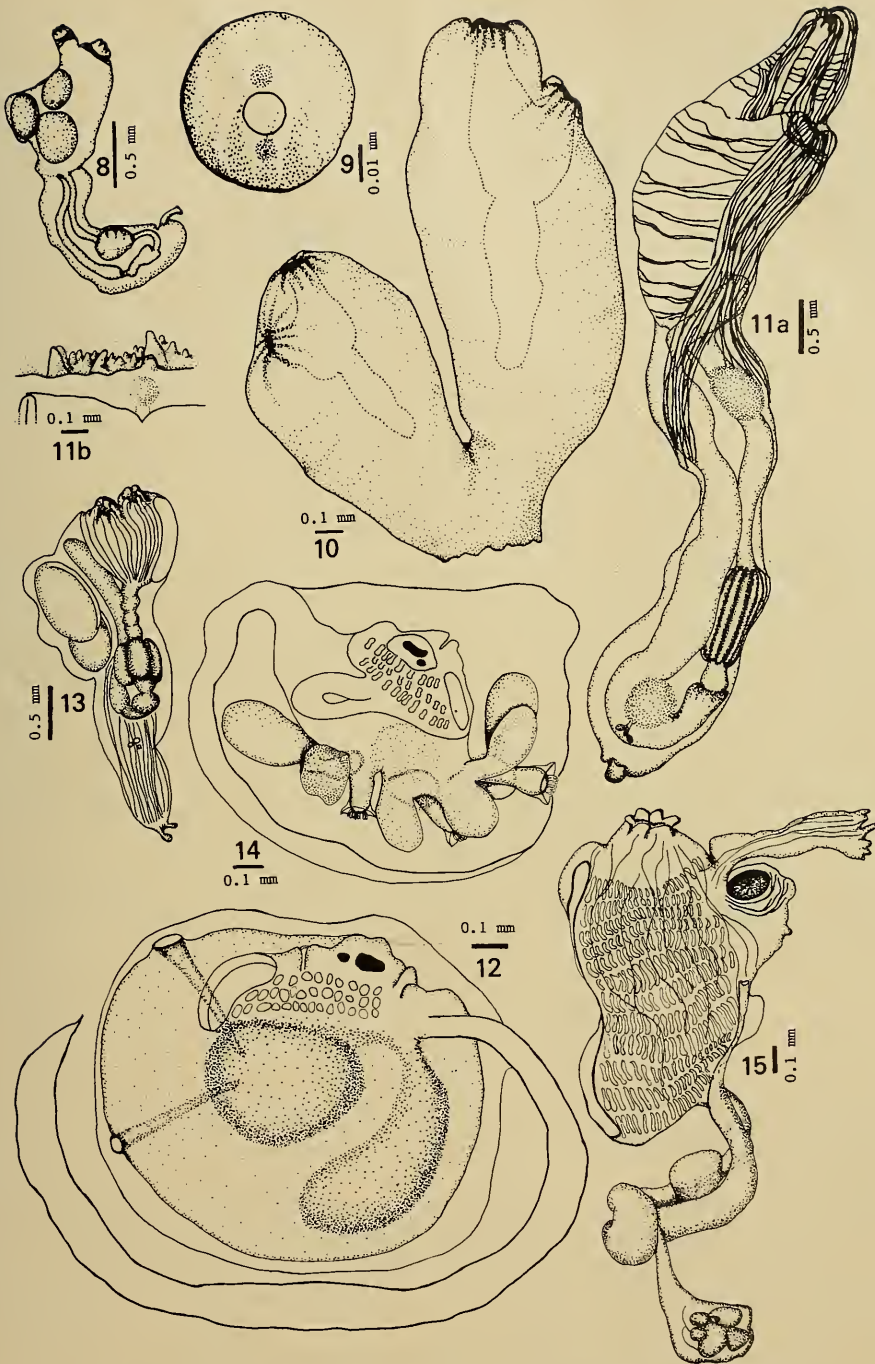
Distribution

Type Location: Fiji — Viti Levu, July 1979: Makaluva, LWM, Holotype QM G124711; Suva Barrier Reef, LWM, Paratype QM G12616.

Description

Colony: The colonies are small irregular cushions, up to 1 cm in length, sometimes with small clavate lobes rising from the surface. The test is translucent, gelatinous, and contains clumps of large (0.05 mm diameter) spherical green cells that are found throughout the test, but are especially around the zooids. These green cells are sometimes contained in what appears to be a spherical cyst from which they are readily liberated by tearing open the wall of the cyst. They may be protozoan. Faecal pellets are also contained in the test.

Zooids: The zooids open independently and are not arranged in systems. In the living colony they are pinkish orange but are colourless in preservative. They are 2 to 3 mm long. There is a conspicuous atrial siphon but the branchial opening is almost sessile. Short sphincter muscles are present around both siphons. About 15 longitudinal thoracic muscles extend along both sides of the abdomen. There are about 15 stigmata in each of the three rows. The abdomen is only slightly larger than the thorax. The rounded stomach is present posteriorly and there is a distinct mid-intestine in the loop



Figs 8-15. 8, 9, *Eudistoma vitata* n. sp. (QM G12471) : 8, zooid. 9, spherical green cell removed from test. 10-12, *Euherdmania digitata* (QM G12470) : 10, part of a colony. 11, — a, zooid; b, branchial tentacles. 12, larva. 13, 14, *Pseudodistoma aurea* (QM GH106) : 13, zooid. 14, larva. 15, *Polyclinum sundaicum* (QM G12611), zooid.

of the gut. There are up to 3 embryos in the peribranchial cavity.

Larvae: The trunk is large (0.7 mm) in relation to the size of the thorax. Larvae have an ocellus and an otolith and are of the usual form for this genus. There are large median ectodermal ampullae alternating with the adhesive organs. The 3 adhesive organs have long stalks, wide shallow ectodermal cups and a central rather flat-topped circular platform of adhesive cells.

Remarks: The zooids of the genus *Eudistoma* present few characters that can be used to distinguish the species, and neither the zooid nor the larva of this species is unique in any way. The form of the colony is variable and the small flat-topped lobes that arise from a flat mat are found in many other species. The green spherical cells that are found in these colonies are distinctive, however, and distinguish them from other *Eudistoma* spp. which have different test inclusions, distributed in different parts of the colony. It is assumed that these green cells do constitute a specific character, as there are no other foreign inclusions in the test. The species resembles colonies of as yet unidentified material taken from similar habitats in the Great Barrier Reef.

Cystodytes dellechiaiei (Della Valle, 1877)

Distoma dellechiaiei Della Valle, 1877, p. 40.

Cystodytes dellachiaiei: Kott, 1972a, p. 11 and synonymy.

Distribution

New Records: Fiji — Viti Levu: Tai Levu, July 1979, LWM, QM G12576; Suva Barrier Reef, July 1980, LWM, QM GH118.

Previously Recorded: The species is pan-tropical, with a latitudinal range from Patagonia and Maria Is., Tasmania, in the south, to the Mediterranean and the Azores (see Kott, 1972a).

Description

Small sessile dirty beige cushions in which the white capsules of spicules around the zooids are clearly evident. The colonies and their zooids are identical with those previously described, although purple pigmented test that has been recorded for some colonies (Kott, 1972a) has not yet been observed in specimens from Fiji.

Remarks: *Cystodytes philippinensis* Herdman (see Tokioka, 1950) is the only other species of this genus known from the Indo-west Pacific. It is distinguished by its spheroidal spicules.

Family POLYCITORIDAE

Subfamily EUHERDMANIINAE

Euherdmania digitata Millar, 1963

Figs 10-12

Euherdmania digitata Millar, 1963, p. 698. Tokioka, 1967, p. 58.

Clavelina dentatosiphonis Millar, 1975, p. 211.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, LWM, July 1979, QM G12470, July 1980, QM G12868; Makaluva Reef, LWM, July 1979, QM G12469; Sandbank Reef, under rubble at side of western channel, July 1980, QM G12867.

Previously Recorded: N.W. Australia — Millar, 1963. Coral Sea — Millar, 1975. Palau Is. — Tokioka, 1967.

Depth Range: 0-100 m. The Fijian specimens were all under rubble.

Description

Colony: Colonies consist of club-shaped vertical lobes about 1 to 2 cm long, joined basally for up to half of their length and with narrow horizontal basal stolons that often extend for a considerable distance on the substrate. Each lobe contains a single

zooid opening on the upper rounded free end of the lobe. The terminal half of each lobe is pale pink, glassy and smooth in life, but the preserved material is collapsed and translucent. The test of the basal part of the lobe is firm and translucent forming a stalk that is often long and narrow.

Zooids: There is a terminal branchial siphon and an atrial siphon anterodorsally. Both siphons are fairly long, each with a conspicuous sphincter muscle around the base. The apertures are protected by 6 accessory lobes. The borders of these lobes are turned inwards, and in these specimens they are smooth rather than dentate. The dorsal lobe of the branchial apertures is large, occupying the whole of the dorsal side of the opening but the lobes around the atrial aperture are all of equal size. There is a velum inside the siphons at the base of the accessory lobes that is also divided into 6 rounded lobes and may be homologous with the border of openings in other species, for it appears that the protective, accessory lobes are produced forwards from the body wall around the periphery of the apertures. There is a dense layer of fine circular muscle bands over the thorax continuing onto the siphons. A conspicuous broad longitudinal band extends along the dorsal border of the body from the atrial siphon to the posterior end of the thorax where it divides to pass around to join a ventral abdominal band of longitudinal muscle. Two conspicuous ventral bands of muscle extend in the thoracic body wall either side of the mid-line and are also continuous with the ventral abdominal band. There are several additional bands of longitudinal muscle extending along the siphons from each accessory lobe that fan out over the thorax. The muscles terminate abruptly at the posterior end of the zooid. The neural gland forms a conspicuous swelling in the pharynx, at the anterior end of the dorsal lamina. The neural duct extends forward for a short distance to a simple opening on a small papilla that projects into the lumen of the gut at the base of the short curved branchial tentacles and just anterior to the straight prepharyngeal groove. The branchial tentacles are in 3 rows. The dorsal lamina is represented by pointed languets. There are 16 rows of 20 stigmata with a wide membrane between successive rows. The oesophagus is long. The stomach is cylindrical when the abdomen is contracted but is pear-shaped when extended. The wide cardiac end of the stomach is about half way down the abdomen. The stomach is yellow in preservative and has 12 parallel longitudinal external folds. There is a duodenal area demarcated from the intestine toward the posterior end of the abdomen and a posterior stomach that is often obscured. The present specimens confirm that the corrugated tube referred to by Millar (1975) is the stomach.

The relative proportions of parts of the zooid are often distorted by contraction. However there is also great variation in the length of the posterior abdomen that may be effected by resorption following sexual reproduction. The posterior abdomen of the specimens from the Palau Is. (Tokioka, 1967), have long posterior abdomina, although only a few scattered ♂ follicles were detected in the anterior part and the heart is present two-thirds of the distance down the posterior abdomen. Specimens from N.W. Australia (Millar, 1963) have less attenuated posterior abdomina. In the present specimens and in the type specimens of *Clavelina dentatosiphonis* Millar, 1975, from the Coral Sea, a distinct posterior abdomen is not present. No gonads were reported for Millar's specimens, but in the Fijian material mature ova and developing embryos are serially arranged in the oviduct, beginning their development at the posterior end of the abdomen. Up to two tailed larvae are present anteriorly in the peribranchial cavity. Fertilization is at the base of the oviduct. Only very few lobed ♂ follicles are occasionally present behind the ovary, to the right of the pole of the gut loop in the present specimens. These are similar to the ♂ follicles described by Millar (1963) and Tokioka (1967).

Blood corpuscles are present in the U-shaped heart posterior to the gut loop. Trophocytes suggestive of subsequent abdominal strobilation are also present along the abdominal body wall. The posterior end of the zooid ends in a rounded knob surrounded by a crown of rounded swellings identical with the condition described by Tokioka (1967, fig. 18e) for this species.

Larvae: Up to 7 developing embryos are present in the oviduct. Well-developed larvae, present in the peribranchial cavity, are especially large, with the larval trunk about 1 mm long. The tail is wound only half way round the body, and there is an ocellus and an otolith. There are two adhesive organs in the mid line covered by the tail where it is wound around the larva. They are long tubes invaginated into the larval trunk from the ectoderm. They are obscured by the yolk (?) material in the larval trunk and can be displayed only by dissection of the larva. This type of adhesive organ is known in other species of *Euherdmania*, viz. *E. claviformis* (Ritter) (see Trason, 1957) and *E. vitrea* Millar, 1961. It also occurs in the genus *Pycnoclavella*, viz. *P. aurilucens* Garstang (see Berrill, 1950), *P. diminuta* (Kott), (see Kott, 1972b), *P. detorta* (Sluiter) (see Millar, 1975) and *P. stanleyi* (Berrill and Abbott) (see Trason, 1963).

Remarks: The species resembles the eastern Pacific *Euherdmania claviformis* (Ritter) (see Van Name, 1945, and Berrill, 1935) and the West African species *E. solida* Millar, 1953 and *E. rodei* Péres, 1949 in its short posterior abdomen, the several rows of branchial tentacles, the long oesophagus, the long folded stomach, the ventral orientation of the branchial siphon and irregularities in the size of the siphonal lobes (the largest being present dorsally), the unusual arrangement of body muscles in dorsal and ventral bands (possibly associated with specialization of the siphonal lobes), the fertilization of eggs at the base of the oviduct. The form of the larva and its adhesive organs are the same as those of *E. vitrea* and *E. claviformis* (Trason, 1957; Millar, 1961). The species are separated by differences in the number of stomach folds, and rows of stigmata, and in the colonies. *Euherdmania australis* Kott (1957b; 1972b) apparently has other affinities and appears not to be directly related to the other species in this genus.

There is no doubt regarding the identity of the present species with *Stomozoa dentatosiphonis*. Although the denticulations on the siphonal lobes are more pronounced in the Coral Sea specimens this, together with the condition of the posterior abdomen are apparently variable characters in this species and possibly in this genus.

A related species, *Stomozoa murrayi* Kott, 1957a (from the Red Sea), the Brazilian Shelf (Millar, 1977) and from South Africa (<*Clavelina roseola*: Millar, 1962) is the type species of the genus *Stomozoa*. It differs from the present species principally in the form of the colony and in the better development of the siphonal lobes. As in *E. vitrea* the zooids are embedded. Millar (1977) has already drawn attention to the similarity of *E. vitrea* and *Clavelina gigantea* Van Name from Florida (?>*E. morgani* Millar and Goodbody, 1974, from the West Indies). Both these species are distinguished from *Stomozoa murrayi* only by their post-abdominal gonads as in *E. digitata* this may be variable, since *C. gigantea*: Tokioka, 1967 (Gulf of Mexico) has abdominal gonads. Thus *E. vitrea*, *C. gigantea*, *E. morgani*, *S. murrayi* and *C. roseola* may indeed be conspecific and *Stomozoa* is more than likely a synonym of *Euherdmania*.

Phylogenetic affinities of *Euherdmania* are unresolved. A relationship between *Euherdmania* and *Pycnoclavella* is based on the form of the peculiar larval adhesive organs. Trason (1957) has argued that this suggests an independent origin from a cionid-type ancestor, rather than an affinity with either the Polyclinidae or the

Clavelinidae (see Van Name, 1945; Millar, 1977). However, although the blastozoids of *Pyncoclavella* form in the terminal ampullae of the stolon vessel as in Clavelinidae, in *Euherdmania* they form by abdominal strobilation as in Polyclinidae and these facts suggest relationships with the Clavelinidae and the Polyclinidae respectively that are no less tenuous than those based on the larval adhesive organs.

Pseudodistoma aurea (Brewin, 1957)

Figs 13, 14

Sigillinaria aurea Brewin, 1957, p. 577.

Distribution

New Records: Fiji — Great Astrolabe Reef: Dravuni, July 1980, LWM, QM GH106.

Previously Recorded: New Zealand (North Auckland) — Brewin, 1957.

Description

Colony: The living colony is a low cushion about 1 cm in greatest extent. It is clear and transparent, 'indian yellow' in colour, with the zooids clearly visible through the test. The colony loses some of its colour in preservative.

Zooids: The zooids open separately to the exterior. They measure about 3 mm when contracted. Six rounded lobes fringe both of the short, anteriorly-oriented siphons. Twelve bands of longitudinal muscles on each side of the thorax continue along each side of the abdomen. There are about 20 stigmata in each of the three rows. The oesophagus is fairly long. The stomach with 4 rounded folds is present in the posterior part of the abdomen and there is a posterior stomach in the pole of the gut loop. There is a small ovary in the anterior part of the short posterior abdomen but the ♂ follicles are expended.

Larvae: Two large embryos, incubating in the oviduct, project from the postero-dorsal corner of the thorax. Mature larvae are sometimes found isolated in the test, the brood pouch having separated from the thorax of the zooid. The larval trunk is 0.6 mm long. The tail is wound half of the way around the trunk. The larvae are of the polycitorid-type with 3 median adhesive organs alternating with median ampullae. Lateral ampullae are present on either side of the base of the median ampullae.

Remarks: The clear test, the colour, the thorax with two anteriorly directed short siphons, the long oesophagus and the large larvae are all identical with those described for the New Zealand specimens.

Ritterella proliferus (Oka, 1933)

Distoma proliferum Oka, 1953, p. 436.

Polycitor proliferus: Tokioka, 1953a, p. 204 and synonymy.

Ritterella proliferus: Kott, 1973, p. 245.

Ritterella dispar Kott, 1957b, p. 102; 1963, p. 78.

Distribution

New Records: Fiji — Great Astrolabe Reef: Yakuve, July 1980, LWM, QM GH102. Lord Howe Is. — QM GH12001.

Previously Recorded: On the northeastern Australian coast this is a common species, high in the intertidal region from Botany Bay on the coast of N.S.W. and on the Great Barrier Reef.

Description

Colony: The colonies form small white cushions up to 1 cm in diameter, flat topped and narrowing to a sessile base. There is sand in the basal test but it becomes more sparse toward the upper surface, where it is absent altogether. The living colonies are pinkish white and translucent, with a bluish iridescent tinge. The zooids are visible through the test as orange points which cause the pink tinge in the colony.

Zooids: The zooids open separately to the surface by two 6 lobed apertures. The thorax has 9 or 10 longitudinal muscle bands that extend along both sides of the abdomen. There are 5 rows of about 16 stigmata. The oesophagus is fairly long. The stomach, with 8 longitudinal folds, is present at the posterior end of the abdomen. Gonads are present in a short posterior abdomen.

Larvae: There are up to two large embryos in the peribranchial cavity (Kott, 1957b).

Remarks: This common species is characterized by the bluish translucent tinge in the white test, and by its small cushion-like colonies. Six rows of stigmata have been recorded for Japanese specimens that are identical in all other respects with those from Australia and the mid-Pacific.

Polyclinum sundaicum (Sluiter, 1909)

Fig. 15

Glossophorum sundaicum Sluiter, 1909, p. 97.

Polyclinum tsutsuii Tokioka, 1954a, p. 240; 1967, p. 47.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, July 1979, LWM, QM G12611; Makaluva, July 1979, LWM, QM G12612; Sand Bank Reef, July 1980, LWM, QM GH88.

Previously Recorded: Indonesia — Sluiter, 1909. Philippine, Palau and Gilbert Is. — Tokioka, 1967. Japan — Tokioka, 1954a.

Description

Colony: The colonies are about 5 mm thick, rounded, soft and gelatinous, fixed basally, the upper surface convex. They extend up to 2 cm in diameter. The outer surface is sandy, but internally the test is transparent, colourless and very soft indeed. Sand is absent only from the zooid openings. There are up to 15 circular systems.

Zooids: Thoraces are delicate and transparent with a large conspicuous atrial tongue that is sometimes pointed but more often ending in a wide straight, but pectinate free end. Thoracic musculature is fine consisting of about 8 longitudinal bands and many fine circular fibres around the apertures. The longitudinal bands do not appear to extend the full length of the thorax, although this may depend on their differential contraction. The muscle fibres in the atrial tongue extend parallel to one another along its length. The atrial opening is posterior to the atrial tongue and is usually produced forwards as is usual in this genus. There is a minute papilla from the body wall just posterior to this aperture. The thorax is large with 12 rows of 20 longish oval stigmata. The horizontal membranes between these rows are broken into conspicuous flattened tongue-shaped papillae opposite each of the stigmata. The abdomen is relatively small. The gut loop is fairly long, flexed ventrally at right angles to the long axis of the zooid, and bent to the right and dorsally at the pole of the loop. The stomach is rounded and smooth, about half way along the proximal limb of the gut loop. The anus opens anterior to the brood pouch. It is usually conspicuously bidentate but in some zooids there are up to 5 rounded lobes.

The small sac-like posterior abdomen, with spherical eggs scattered amongst the smaller pear-shaped ♂ follicles, is joined to the concave or dorsal side of the distal end of the abdomen.

There is usually a conspicuous brood pouch, formed by the swollen distal portion of the oviduct, which bends back on itself before it opens into the atrial cavity from the outer wall of the right peribranchial cavity at about the level of the 7th row of stigmata. Up to 6 embryos are present in the brood pouch, the best developed anteriorly and ventrally. In many zooids well-developed embryos are found free in the peribranchial cavity.

Larvae: Larvae are small. The trunk is 0.57 mm long, and the tail is wound about 3/4 of the way around it. There are three adhesive organs in the mid line with very shallow ectodermal cups. Rounded median ampullae are present between the adhesive organs, and paired lateral ampullae are present on either side of the anterior end of the trunk. Ectodermal vesicles are also present on either side of the mid line postero-ventrally and antero-dorsally.

Remarks: The present colonies are identical with many of those described by Sluiter (1909, from Station 58) and Tokioka (1954, larger colonies with many systems). There are no small colonies consisting of only a single system in the present collection. The species shares its large flattened branchial papillae (that Sluiter, 1909, regarded as characteristic of the genus *Glossophorum*) with *P. constellatum* and *P. vasculosum* (see Tokioka, 1967), but it is distinguished by its simple circular systems and the number of long rows of stigmata. The larvae do not have the thick granular test of *Polyclinum vasculosum* (see Tokioka, 1961). The external sand encrustation appears also to be a variable character that is certainly affected by the age, and possibly by the habitat of the species. *Polyclinum saturnium* (see Tokioka, 1962) also shares many characters with the present species but is distinguished by its very long posterior abdominal neck and short thoracic musculature.

The larvae of all species of *Polyclinum* are very similar. They are all small and have very shallow adhesive organs, and usually postero-ventral and antero-dorsal groups of ectodermal vesicles that separate from posterior extensions of the lateral ridge either side of the mid-line. Most of the larvae also have paired lateral ectodermal ampullae either side of the median ampullae that alternate with the suckers. Larvae of some species of *Synoicum* have similar characters, but the subdivision of anterior ampullae into vesicles that generally occurs in *Aplidium* and *Synoicum* has not been observed in *Polyclinum* (see Kott, 1963). Note should be taken of the very marked similarity between zooids of *Sidneioides* spp. and *Polyclinum* spp. The atrial aperture and tongue, the general structure of the thorax, abdomen and posterior abdomen, the small papilla beneath the atrial aperture and the larvae are similar in both genera. The thoracic ovary of *S. japonense* (see Millar, 1975) is in the same position as the brood pouch in the present species. Although the former characters may indicate some phylogenetic affinity, the latter is associated with the shortening of the oviduct that lies to the right of the mid line in the thorax.

Synoicum kuranui Brewin, 1950

Synoicum kuranui Brewin, 1950, p. 355, Millar, 1960, p. 49. Kott, 1963, p. 88.

?*Synoicum ?clavatum*: Millar, 1975, p. 255.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, July 1980, LWM, QM GH97.

Previously Recorded: Queensland (Heron Is.) — Kott, 1963. New Zealand (Great Barrier Is., off North Cape) — Brewin, 1950; Millar, 1960.

Description

Colony: The colonies consist of sandy, solid, basal test with the surface divided into separate shallow lobes, each invested with sand in the lower part but quite naked terminally where the test is translucent. The colonies are about 1 cm high.

Zooids: The zooids are 'crimson' in preservative. They are small, with a long, thread-like posterior abdomen. There is an undivided atrial lip from the upper border of the opening. The thorax has about 6 longitudinal muscles on each side that extend along the ventral border of the abdomen, causing it to curl up when contracted. There are 10 rows of about 15 stigmata. The stomach is smooth.

Remarks: In this genus, the zooids show little variation in their morphology, and

species are notoriously difficult to identify. The colony is identical with that described by Millar (1975) as *S. ?clavatum*. However the latter species (see Tokioka, 1954c) is larger, there are more rows of stigmata and the rounded heads have narrow stalks, rather than the broad cylindrical lobes of the present colonies, and of Millar's specimens. Although Millar's (1960) specimens of *S. kuranui* were larger than the present colonies, the type specimens are of the same order of size as the Fijian material and other characters, including the 'crimson' colour are the same.

The records suggest that the species is a tropical component of the New Zealand fauna.

Aplidium depressum Sluiter, 1909

Aplidium depressum Sluiter, 1909, p. 102. Van Name, 1918, p. 167. Kott, 1963, p. 95. Millar, 1975, p. 245.

Distribution

New Records: Fiji — Great Astrolabe Reef: Dravuni, July 1980, LWM, QM GH86.

Previously Recorded: Philippines — Van Name, 1918; Millar, 1975. Indonesia — Sluiter, 1909. Central Queensland (Bundaberg) — Kott, 1963.

Description

Colony: The colonies form small, rather flat investing sheets about 3 mm thick. The test is colourless and translucent and in preservative the buff zooids are clearly seen through it. The surface is smooth, but the base of the colony is very irregular, extending into the interstices of the irregular coralline substrate, making it very difficult to remove. In the preserved colony the zooids are withdrawn deeply into the basal test.

Zooids: The small and short zooids (less than 1 mm) have about 8 rows of about 8 stigmata. There are 12 longitudinal stomach folds. The atrial opening is not protected by a lip.

Remarks: Although the present specimens have more rows of stigmata than are previously recorded for this species, the absence of an atrial lip and the flat translucent colonies are regarded as diagnostic.

Family DIDEMNIDAE

The taxonomy of the family Didemnidae has been given special attention. It has been notoriously difficult, owing to the small size and consequent simplification of the zooids. In general, the size and shape of the thorax and of the retractor muscle are subject to such variation owing to contraction of the muscles, that precise measurements are meaningless. The point from the posterior end of the thorax or from along the oesophagus that the retractor muscle is free from the rest of the zooid is also variable and a consequence of the state of contraction of the musculature. The length of the distal part of the oesophagus (beyond the point where the retractor muscle is free of the body wall) and the shape and structure of the rest of the abdomen are not so affected, and consequently present more reliable characters that have been given more emphasis in this study. The study of the living specimens, previously not possible where expedition and other museum collections form the basis for most of the works on this and other families of the Ascidiacea, has been only of limited use in determining species parameters owing to similarity of colonies and wide and considerable overlap of colour range in most of the species. The form and distribution of the pigment cells and pigment that is visible in freshly preserved material, however, has been found to be a reliable character in the determination of some of the species. Confidence in the use of this character will be based on the data that are available

regarding the characteristics and behaviour of the pigments in preservative over extended periods. Little information is available at present.

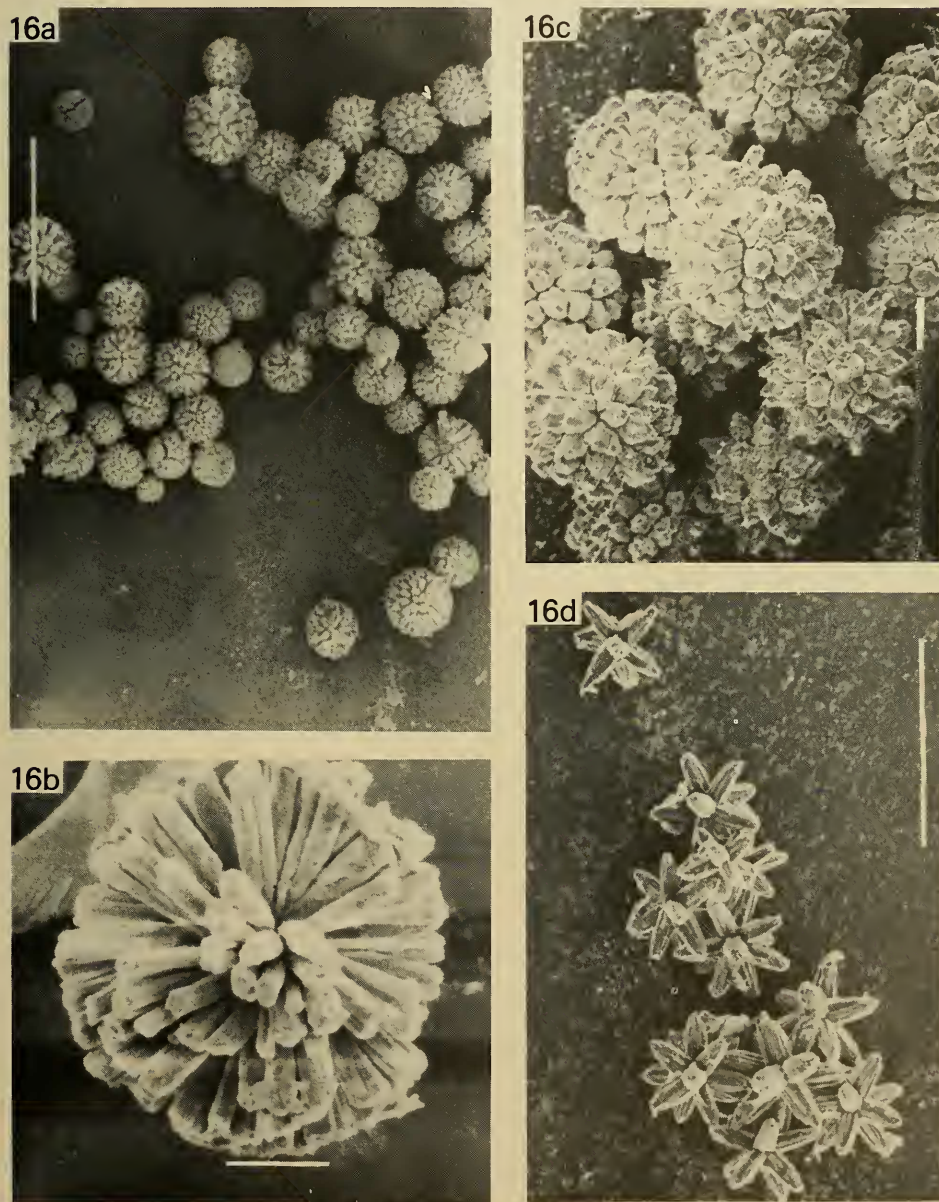


Fig. 16. a, b, *Didemnum albopunctatum* (ZMA TU433.2) spherical spicules varying in size, with loose flat ended rays, 0.01-0.04 mm (scales a, 0.05 mm, b, 0.001 mm); c, *Didemnum chartaceum* (ZMA TU437) stellate spicules with many short conical or rounded rays, 0.01-0.03 mm (scale 0.005 mm); d, *Didemnum cuculliferum* (QM G12594) stellate spicules with few, very long parallel-sided rays, 0.02-0.04 mm (scale 0.05 mm).

Examination of the calcareous spicules of species of the Didemnidae, by scanning electron microscopy, has revealed complexity and diversity in their structure that was not recognized previously and that are beyond the resolution of the light microscope. The relationships of the different types of spicules, and the significance of their structural variations are not fully understood. In some cases it is possible that spicules lose rays which are later regenerated (see *Didemnum digestum*, *D. sphaericum* and *Leptoclinides* spp.). Nevertheless, it is clear that the details of the structure and, within certain limits, the size of the spicules are genetically determined and are important taxonomic characters.

Certain species of the family Didemnidae are associated with prokaryotic plant cells of the genus *Prochloron* Lewin, 1977. The species of this group of the Didemnidae in which the association is obligatory have been discussed in detail by Kott (1980). Additional information on those that are now known to occur in Fiji (Table 2) is set out below. Details of records are given only where the species has not previously been recorded from the location referred to. The species *Trididemnum cerebriforme* which apparently has a non-obligatory association with plant cells often present on the surface of the colony is also discussed below.

Didemnum albopunctatum Sluiter, 1909

Figs 16a, b; 20

Didemnum albopunctatum Sluiter, 1909, p. 58 (part, specimens from Sts 89 and 231)

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, LWM, July 1979, QM G12591.

Previously Recorded: Indonesia — Sluiter, 1909.

Description

In addition to the newly-recorded material the following specimens have been examined: *Didemnum albopunctatum* Sluiter, 1909, St. 231, Lectotype, ZMA TU433.2; St. 89, Paralectotype ZMA TU433.4; St. 273, Paralectotype ZMA TU433.1 (<*Didemnum* sp.?) ; St. 144, Paralectotype, ZMA TU433.3 (<*Didemnum* sp.?). Lectotype and paralectotypes designated by Van der Spoel (1969).

Colony: Fijian colonies are irregular and very thin and elongate. In life they are purple, with contrasting white around the borders and over the anterior end of each zooid, and sometimes around the cloacal apertures where the superficial layer of bladder cells mixed with pigment cells is thin allowing the spicules to show through. The colour is brown in preservative. There are 3 or 4 large open cloacal apertures along the surface of the colonies.

The cloacal cavity is primarily thoracic, the basal test is thin and the abdomina are curved up alongside the thoraces, and project up into the common cloaca. The spicules are 0.01-0.04 mm, spherical, with dense flat-ended parallel-sided rays and are present throughout the test. They are sometimes absent from around the border of the cloacal apertures. The pigment cells are small and spherical to oval.

Zooids: These are evenly spaced and quite dense. They are brown in preservative with minute pigment cells in the body wall. There are 6 pointed branchial lobes, and the atrial aperture is wide exposing the mid-dorsal part of the branchial sac. There is a conspicuous muscular atrial lip in the centre of the upper border of the opening, and fine longitudinal thoracic bands. The thorax is only about 0.5 mm long. There is a fairly short to medium-length retractor muscle from the posterior end of the thorax into which the usual fibres from between the rows of stigmata and from the outer body wall extend. There is a shallow lateral organ on each side of the endostyle opposite the third row of stigmata. There are 10 elongate stigmata per row. The oesophageal neck is fairly long and bends ventrally, the abdomen lying at right angles to the vertical axis

of the zooid. The distal part of the gut loop is also curved upwards. It is not twisted, however, as it is in *D. chartaceum* (see Hastings, 1931) which also has the abdomen alongside the thorax. There is conspicuous glandular material, forming a deep V in the loop of the gut. Mature gonads are not present in either the Fijian or Indonesian material.

Remarks: These soft thin colonies with quite extensive cloacal cavities, heavily pigmented, possibly always purple when living and with white circular areas over the zooids and around the borders of the colony where the pigment is missing, are very characteristic. The Fijian colonies do not differ from the Siboga material (Sluiter, 1909) in any way. The V of glandular material in the gut loop is also present in *D. cuculliferum* (see below), which is sometimes (but not always) of a purple colour. The latter species also has a similar rather long gut loop and a similarly placed lateral organ. It lacks an atrial lip, however, has fewer stigmata in each row, a long retractor muscle, characteristic surface papillae and unique spicules that distinguish it. *Didemnum edmondsoni* Eldrege, 1977, from Hawaii, resembles *D. albopunctatum* in many characters, especially in its pigmentation. The presence of some stellate spicules distinguishes it.

Polysyncrator recurvatum (Sluiter, 1909) and *Didemnum chartaceum* Sluiter, 1909, also have spherical spicules and the gut loop bent up level with the thorax. They both lack the pigment cells of the present species. Further, *P. recurvatum* does not have an atrial lip, has the divided ♂ follicle characteristic of the genus, and has characteristic white cells in the buff body wall. *Didemnum chartaceum* has an atrial lip and medium length retractor muscle similar to those of the present species but it has a more conspicuous superficial bladder cell layer, a less distinctive colour pattern, has stellate spicules that are absent from the central test and the thoracic cloacal cavity is very shallow.

The specimens of *D. albopunctatum* Sluiter from Siboga stations 273 and 144 are large, hard investing colonies. Superficially the pigmentation of the preserved specimens is similar to that of the present specimen, but some larger pigment cells are present, the cloacal cavity is more restricted and the spicules are distinctly stellate. They are colonies of apparently undescribed species and are not conspecific. One (ZMA 433.3, St. 144) is probably conspecific with *D. jedanensis*: Hastings, 1931, from Low Is. (BM 1930.12.17.66). *D. jedanensis* Sluiter, 1909 (ZMA 454.3, St. 303) however, is a species of the genus *Polysyncrator*.

Didemnum chartaceum Sluiter, 1909

Figs 16c; 21

Didemnum chartaceum Sluiter, 1909, p. 57.

Didemnum chartaceum: Hastings, 1931, p. 97.

Distribution

New Records: Fiji — Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH55.

Previously Recorded: Indonesia — Sluiter, 1909. Great Barrier Reef (Low Isles) — Hastings, 1931.

Description

In addition to the newly-recorded material the following specimens have been examined: *Didemnum chartaceum* Sluiter, 1909, St. 50, Syntypes, ZMA TU437; Hastings, 1931, St. XVI, BM 1930.12.17.45.

Colony: The colonies form investing sheets, as in the holotype. The living specimens are 'orpiment orange'. In preservative the zooids are orange at first but the colour gradually fades and the test and zooids are grey in the holotype. Pigment cells are minute and the pigment appears to be diffused through the colony. There is a

superficial layer of bladder cells and beneath this a single layer of spicules at the level of the branchial siphons. Two or three spicules are also present in the tips of the branchial lobes. Only very sparse spicules are present in the base of the colony and they are otherwise absent from the remainder of the test. There is a thoracic common cloacal cavity. The surface layer of test is very thin indeed, accommodating only the superficial bladder cell layer and the layer of spicules. Each thorax crosses the cloacal cavity in a separate test sheath. The abdomina of the zooids are embedded in the soft basal test. The cloacal apertures, with spicule-free borders, are randomly distributed on the surface of the colony.

The spicules are large, up to 0.06 mm. The majority have numerous short conical pointed rays, but spherical spicules with blunt-ended rays are also present.

Zooids: The zooids are of moderate size. The branchial lobes are not deeply incised. The atrial aperture is wide and its anterior border is produced into a long forked lip, although this may sometimes be quite short and inconspicuous. There are concave oval lateral organs packed with spicules on each side of the endostyle. There is a moderately long retractor muscle from the posterior end of the thorax near the neck of the zooid. The branchial sac has 8 stigmata in each of the 4 rows. The gut loop is simple and vertical. There were no gonads in the Fijian colonies. However, the Low Isles colony has 6½ coils of the vas deferens around a single ♂ follicle. The abdomen is bent up alongside the thorax in the Low Isles specimen (Hastings, 1931) only when the colony is compressed.

Remarks: The species can be identified in the field by its bright colour. The atrial tongue is distinctive, as are the large stellate and globular spicules.

Didemnum cuculliferum (Sluiter, 1909)

Figs 16d; 22a, b

Diplosomoides cuculliferum Sluiter, 1909, p. 90.

Didemnum nekozita Tokioka, 1967, p. 67.

?*Didemnum moseleyi*: Eldredge, 1967, p. 210 (part).

Distribution

New Records: Fiji — Viti Levu: Makaluva, July 1979, QM G12594; Suva Barrier Reef, July 1979, QM G12593; ?Mumbualau, July 1980, QM GH56. Palau Is. — QM G12678.

Previously Recorded: Indonesia — Sluiter, 1909. Palau Is. and Philippine Is. — Tokioka, 1967. Eniwetok — Eldredge, 1967.

Description

In addition to the newly-recorded material the following specimen was examined: *Diplosomoides cuculliferum* Sluiter, Holotype ZMA TU 490.

Colony: The colonies are small usually irregular cushions to large irregular investing sheets, all about 3 mm thick and usually soft to the touch. There are often a large number of small colonies growing close together, their borders contiguous. This may be the result of lobulation. The living colonies are 'auricula purple', 'scarlet', 'poppy red', 'geranium red', 'flesh colour', 'salmon colour' and 'vinaceous buff' with white where the branchial apertures open to the surface. In preservative they are always white. The borders of the colony are always rounded. The surface test is produced into pointed papillae with a 6-lobed branchial aperture at the base or on the side of the wide base of one of these papillae. There is a superficial layer of bladder cells mixed with small pigment cells that rapidly fade in preservative. Spicules are present throughout the test beneath the bladder cell layer. The spicules interrupt the bladder cell layer over the anterior ends of the zooids and extend into the pointed papillae that project from the surface of the test. The branchial lobes are outlined with spicules

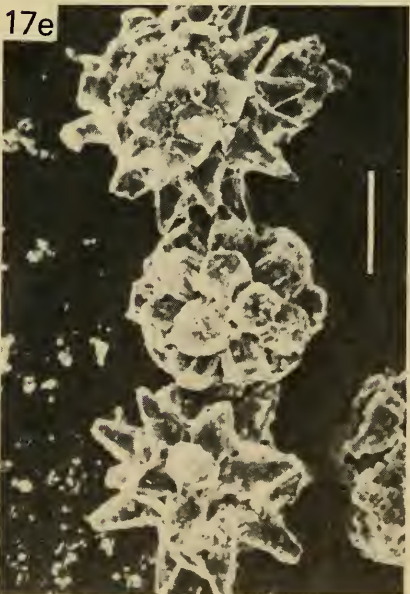
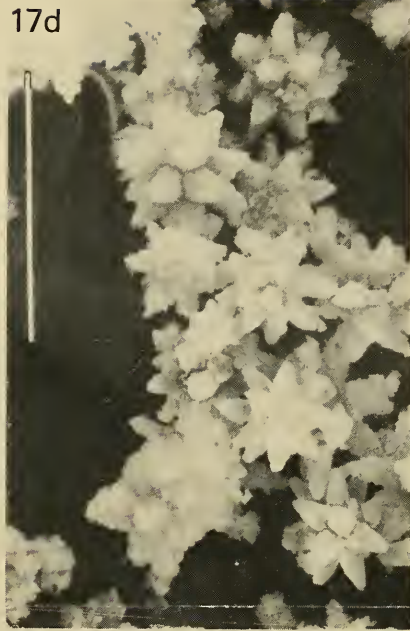


Fig. 17. a, b, c, *Didemnum digestum* stellate spicules with conical rays often missing, extending from the centre of basal concavities, 0.02-0.05 mm (a, ZMA TU442.2 scale 0.005 mm; b, c, QM G12614 scale 0.01 mm; d, *Didemnum granulatum* (QM G12589) stellate spicules with long pointed rays, 0.02-0.03 mm (scale 0.05 mm), e, *Didemnum moseleyi* (QM G12586) stellate spicules with a variable number of rounded or conical rays, 0.02-0.05 mm (scale 0.001 mm).

where they open to the surface on the pointed papillae. The spicules are distinctive, with a total of only 6-8 long pointed rays. They are 0.02-0.06 mm in diameter between the distal points of the rays. The cloacal cavity is thoracic, and spacious, the surface test being relatively thin. This results in the soft feel of the colonies. The basal test enclosing abdomina and larvae, is relatively thick, but the abdominal portions of zooids often protrude into the thoracic cavity in clumps. In the specimens from Mumbualau (QM GH56), there are no surface papillae, and the common cloaca extends posterior to the zooids, the basal test being especially thin. The posterior abdominal cloacal cavity is traversed by the basal test connectives that support clumps of zooids at the surface.

Zooids: These are about 1 mm long. They are orange when freshly preserved but this colour rapidly fades. The branchial aperture is on a short siphon with a distinct circular sphincter muscle. The atrial aperture is a wide opening exposing a large part of the dorsal section of the branchial sac. There is a very long slender retractor muscle from the proximal part of the oesophageal neck extending well posterior to the end of the abdomen. There are 4 rows of 6 elongate stigmata. There is a small outwardly projecting lateral organ at the level of the third row of stigmata. The proximal part of the abdomen is more or less vertical although the distal section of the gut loop is bent upwards. There are $8\frac{1}{2}$ coils of the vas deferens around the large pyriform ♂ gland. There is a dense mass of glandular tissue in the loop of the gut that appears to be associated with the gastro-intestinal gland. It forms a rather diffuse curved plate and in section appears as the two elongate glands described by Tokioka (1967) and that were referred to as elongate ♂ follicles by Sluiter (1909).

Larvae: Immature embryos are present in the basal test in Fijian material (QM G12593-4). Tokioka reports that the larvae are similar to those of *D. moseleyi*. This could not be confirmed in the present specimens, which have a swollen area anteriorly, to the left of the coiled tail, where two adhesive organs appear to be developing.

Remarks: The spicules and colony of this species together with its relatively large zooid, long slender retractor muscle, long curved gut loop and pyriform testes with numerous coils of the vas deferens are distinctive.

Eldredge (1967) includes papillate specimens with tetrahedral spicules, long retractor muscle and a large number of vas deferens coils in *D. moseleyi*. These are very possibly colonies of the present species.

The similarity between this species and *D. sphaericum* is discussed below.

Didemnum digestum Sluiter, 1909

Figs 17a-c; 23

Didemnum digestum Sluiter, 1909, (part, not specimen from St. 315).

Distribution

New Records: Fiji — Viti Levu: Laucala Bay, 10 m, sandy, July 1979, QM G12614.

Previously Recorded: Indonesia — Sluiter, 1909.

Description

In addition to the newly recorded material the following specimens have been examined: *Didemnum digestum* Sluiter, 1909, St. 127, Paralectotype, ZMA TU442.2; St. 315, Paralectotype ZMA TU442.1 (<*Didemnum* sp?), (Van der Spoel, 1969).

Colony: The Fijian colony is an investing sheet only 1 mm thick. The living specimens are apricot, but preserved specimens are white. There is a conspicuous superficial layer of bladder cells, and beneath this the spicules are dense throughout the thickness of the colony. Only the branchial apertures with associated spicules project up through

the bladder cell layer and appear as evenly spaced, white dots in the surface. There is a shallow thoracic cloacal cavity.

The spicules are stellate, but the rays are often missing. Scanning electron micrographs show that in the majority of spicules the terminal portion of each ray is rounded and arises from the centre of a wider base that is irregularly hexagonal in section. The terminal portion of the ray is often very short and surrounded by a projecting outer part of the basal section in which it is supported. However in some of the rays on each spicule the terminal section is long and pointed. These longer rays often arise from either side of the spicules, or there are up to 5 in the one equatorial plane around the spicules. The central portion of the spicules, to the edge of the basal part of the rays, is 0.02-0.03 mm in diameter. The length of the distal part of the rays, however, is from 0.005 to 0.015 mm, so the largest dimension of the spicule from tip of the rays is from 0.02 to 0.06 mm. There are also stellate spicules with almost parallel-sided rays, without basal sections.

Zooids: These are evenly distributed in the test and are small, the thorax being only 0.3 mm long. The abdomen, embedded in the basal test, lies horizontally at right angles to the long axis of the thorax. The branchial siphon is fairly long to accommodate the superficial layer of bladder cells. The atrial opening is wide. There is a short but thick retractor muscle projecting posteriorly from the posterior end of the thorax in line with the long axis of the zooid. There are only 4 oval stigmata in each of the four rows. The single ♂ follicle is rather flat with 6½ coils of the vas deferens around it. There are vascular processes from the abdomen.

Remarks: *Polysyncraton recurvatum* (Sluiter) and *D. albopunctatum* Sluiter have small zooids and abdomina bent at right angles to the thorax. The present species is distinguished by its long branchial siphons, unique spicules, lesser number of smaller stigmata in each row, and the lack of pigment in the surface of the colony.

The paralectotype specimens from Station 127 (ZMA TU442.2) are investing sheets, in contrast with the present small colonies. They have surface furrows where the surface test is depressed over the cloacal cavities that surround a circle of zooids. These are not present in the smaller Fijian colony where the cloacal system does not appear to have reached its full development. The spicules in the Fijian specimens also have far more rays broken off than in the paratype that was examined.

Sluiter (1909) thought the specimen from Siboga Station 315 (ZMA TU442.1) was conspecific with this species. However the spicules are large with many acutely-pointed rays. It also has a very much smaller thorax, and is distinct from the present species, despite the similarity of the cloacal system and the general appearance of the colony.

There is a striking similarity between this species and *Didemnum sphaericum*, based on the small zooid and the form of the spicules. The spicules of *D. digestum* are larger and the testis follicle is flatter. The colonies are investing sheets, and are thinner, with abdomen at an angle to the zooid and the bladder cell layer is more conspicuous than in *D. sphaericum*.

Didemnum granulatum Tokioka, 1954

Figs 17d; 24

Didemnum moseleyi f. *granulatum* Tokioka, 1954a, p. 244; 1967, p. 67.

Didemnum pele Eldredge, 1967, p. 197.

?*Didemnum moseleyi*: Kott, 1972a, p. 19; 1972b, p. 17; Eldredge, 1967, p. 210 (part).

Distribution

New Records: Fiji — Viti Levu: Tai-levu, LWM, July 1979, QM G12592; Suva

Barrier Reef, LWM, July 1979, QM G12589, G12590; July 1980, QM GH133. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH73, 129; Yakuve, LWM, July 1980, QM GH69.

Previously Recorded: Palau Is. — Tokioka, 1967. Japan (Tokara Is.) — Tokioka, 1954a. Hawaii (Oahu, 120 m) — Eldredge, 1967. Palmyra, Ifaluk Atoll — Eldredge, 1967. Circum-Australian — Kott, 1972a, b.

Description

Colony: Living colonies are 'vermilion', 'poppy red', 'geranium red', 'cadmium orange', 'vinaceous buff' and 'salmon colour'. They are thin and investing, and of variable size. The colonies are brittle with densely packed spicules. There is no superficial bladder cell layer. Very small brownish-orange pigment cells are mixed with the spicules in the surface layer of test. Small evenly-spaced spicule-filled papillae usually protrude from the surface of the colony between the branchial openings. Lobes of the branchial openings are lined with one or two rows of spicules. The apertures may be depressed into the surface of the test and often the test over the ventral branchial lobe may be enlarged to form a papilla protecting the aperture. The common cloacal cavities are thoracic but quite extensive and become deeper around clumps of zooids. Elongate to round common cloacal apertures are sessile. The spicules are less dense in the test around the cloacal apertures, but sometimes there are ribs of dense spicules in the roof of the cloacal cavity surrounding these apertures (as described by Tokioka, 1967). Flat oval spicule-filled projections from halfway along the free edges of each separate thoracic test sheath are associated with the lateral organs of the zooids.

The spicules are conspicuously stellate, 0.02-0.03 mm in diameter with 5-7 long almost parallel-sided but pointed rays in optical transverse section.

Zooids: These are buff, with brown-yellow pigment cells when freshly preserved but they quickly fade. The branchial aperture has 6 conspicuous lobes and the atrial opening is wide, exposing most of the dorsal part of the branchial sac. Four fine thoracic muscles are sometimes conspicuous on the thorax. There is a short to medium length retractor muscle that is free from the middle of the oesophageal neck. There are four rows of 6 stigmata. When the zooid is extended the stigmata are seen to be narrow and elongate in the anterior rows, but become progressively shorter toward the posterior end of the thorax. The fourth row, at the posterior end of the thorax, is inconspicuous, can only be observed in the extended zooid or by careful dissection and has very short oval stigmata. The oesophageal neck is long and vertical. Posterior to the stomach the gut loop is bent upwards. There is a small posterior stomach and a duodenal constriction. There are 6½ coils of the vas deferens around the outer half of the single rather flattened ♂ follicle. Mature ♂ follicles and well-developed eggs are present in all colonies.

Larvae: These are present in basal test in some colonies (QM G12590). They are of the usual didemnid type, about 0.7 mm long with 3 median adhesive organs, 4 pairs of lateral ectodermal ampullae, an otolith and an ocellus. The larva described by Eldredge is immature and the separation between the lateral ampullae on each side is not complete.

Remarks: The present species has undoubtedly been confused with *D. moseleyi*. Its long-armed and dense stellate spicules, absence of bladder cell layer, double gut loop, medium length retractor from the oesophageal neck, and very short posterior row of stigmata are together distinctive. The spicules resemble those of *D. viride* Herdman, 1906, from Ceylon (see Kott, 1980).

The synonymy of many of the specimens of *D. moseleyi*: Eldredge, 1967, is proposed on the basis of the long, pointed rays of the spicules, the origin of the

retractor muscle from the oesophageal neck, both of which resemble *D. granulatum* rather than *D. moseleyi* (Herdman).

Didemnum molle (Herdman, 1886)

Diplosomoides molle Herdman, 1886, p. 310.

Didemnum molle: Kott 1980, p. 2 and synonymy.

New Records: Mumbualau, on sea grass, LWM, July, 1980.

Remarks: The species has a wide range in the Indo-west-Pacific and has been recorded from a wide range of habitats (Tokioa, 1967). Although it occurs commonly on coral substrates at other locations, its occurrence in Fiji appears to be restricted and this is the only record.

Didemnum moseleyi (Herdman, 1886)

Figs 17e; 25

Leptoclinum moseleyi Herdman, 1886, p. 272.

Leptoclinum incanum Herdman, 1899, p. 90. Herdman and Riddell, 1913, p. 888.

Didemnum moseleyi: Sluiter, 1909, p. 45; 1913, p. 74. Van Name, 1918, p. 151.

Tokioka, 1949, p. 43; 1953a, p. 185; 1954a, p. 243; 1955a, p. 212; 1955b, p. 44;

1961, p. 106; 1967, p. 65; 1970, p. 52; Kott, 1957, p. 136; 1962, p. 328.

Not *Didemnum moseleyi*: Kott, 1972a, p. 19; 1972b, p. 17 (?<*D. granulatum*);

1976, p. 65. Eldredge, 1967, p. 210 (?<*D. granulatum* and *D. cuculliferum*).

?*Didemnum grande*: Van Name, 1918, p. 151 (part, No. 7 and 15).

Distribution

New Records: Fiji — Viti Levu: Tai Levu, LWM, July 1979, QM G12586; Laucala Bay, 10 m, QM G12498; Mumbualau, LWM, July 1980, QM GH130; Suva Barrier Reef, LWM, July 1980, QM GH 74, 132. Great Astrolabe Reef: Yakuve, LWM, July 1980, QM GH67, 69, 131. Great Barrier Reef — Green I., August 1978, LWM, QM G12497.

Previously Recorded: Japan — Tokioa, 1949, 1953a. Japan (Tokara Is.) — Tokioa, 1954a. Gulf of Suez — Kott, 1957a. Philippines — Herdman, 1886; Van Name, 1918; Tokioa, 1967, 1970. Palau Is. — Tokioa, 1955b, 1967. Noumea — Tokioa, 1961. Circum-Australia — Kott, 1962. Indonesia — Sluiter, 1909, 1913; Tokioa, 1955a. A common and ubiquitous Indo — west Pacific species.

Description:

Colony: Colonies are irregular and investing thin sheets of varying size. In life they are 'orange chrome', 'poppy red', 'light saturn red', 'flesh coloured', 'maize yellow', often with white spicules showing around the borders and cloacal apertures where the pigment is absent. The preserved specimens are white and pinkish-apricot with clear apricot or brownish or colourless zooids. The zooids are evenly spaced, surrounded by a thoracic common cloaca. There is a superficial layer of bladder cells, mixed with minute pigment cells and spicules. This results in the frothy appearance of the superficial layer of the test. The pigment cells are especially small and the pigment appears to be more diffuse than in other species. There may be accumulations of spicules in the surface and often spicule-filled papillae project from the surface on some parts of the colony. The spicules are dense throughout the remainder of the test. Spicules fill, but do not outline, the branchial lobes where they open to the surface. The basal test beneath the common cloacal apertures is often produced upwards to form a plug in the opening.

The spicules are 0.02-0.05 mm. They are stellate and of two types, with either 7-11 broad conical rays, or more numerous parallel-sided rays with rounded ends.

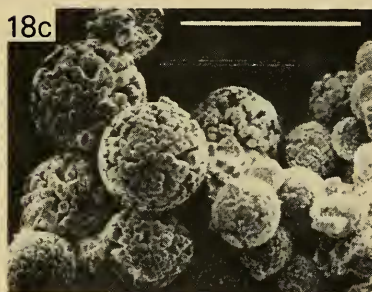
Zooids: The thorax is about 0.5 mm, with the usual 6-lobed branchial aperture. The lateral organ projects from the margin of the wide atrial aperture. A short retractor



18b



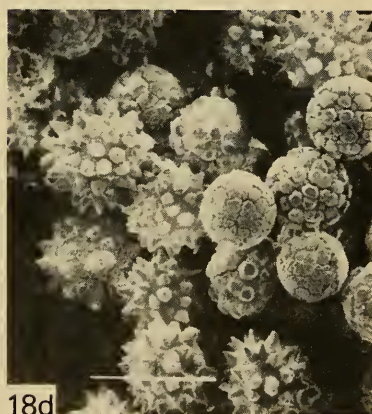
18a



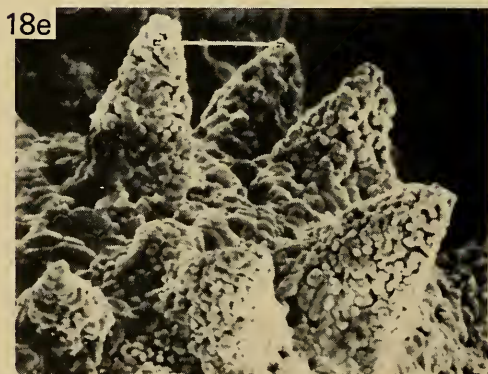
18c



18f



18d



18e

Fig. 18. a, *Didemnum proliferum* (QM G12577) spherical spicules with loose flat-ended rays, 0.01-0.03 mm (scale 0.005 mm); b, *Didemnum sphaericum* (QM GH127) stellate spicules with straight rays and with rays from centre of basal concavity, 0.015-0.03 mm (scale 0.005 mm); c, *Polysyncraton recurvatum* (QM GH105) spherical spicules with flat-ended rays, 0.01-0.04 mm (scale 0.05 mm); d-f, *Polysyncraton doboense* (QM GH143) stellate and some spherical spicules, crystalline structure obscure, 0.03-0.04 mm (scales d, 0.05 mm; e, f, 0.005 mm).

muscle from the posterior end of the thorax extends no more than the length of the oesophagus. There are 4 rows of 6 stigmata. The proximal part of the gut loop is vertical but the pole of the loop is sharply flexed upwards. The gut is conspicuously divided into a post-stomach, a duodenal area and a rectum which is markedly enlarged proximally. There are $6\frac{1}{2}$ coils of the vas deferens around the single rather flattened ♂ follicle.

Larvae: There were no larvae present in these specimens. They are known to be of the characteristic didemnid type with 3 median adhesive organs and paired lateral ampullae.

Remarks: There has been undoubted confusion in defining this ubiquitous species owing to the absence of conspicuously unique characters. However, the two types of spicules, each with different types of rays, together with the superficial bladder cell layer, into which the spicules extend, the short retractor muscle from the posterior end of the thorax and the predominantly vertical gut loop with a sharply flexed pole and its conspicuous subdivisions together with the flattened testis follicle help to distinguish it. The stellate spicules have shorter, thicker and less acutely pointed and more numerous rays than those of the closely related *D. granulatatum*.

Van Name (1918) has drawn attention to the similarity between zooids of this species and of specimens he had assigned to *D. grande*. The type and size range of the spicules are also identical.

Didemnum proliferum n. sp.

Figs 18a; 26

Didemnum candidum: Hastings, 1931, p. 94 (part: shore specimens with 'burr-like' spicules).

Didemnum candidum: Tokioka, 1967, p. 62 (part: specimens with single ♂ follicles and spherical spicules).

?*Didemnum candidum*: Eldredge, 1967, p. 213 (part: specimens with numerous blunt rays).

?*Didemnum candidum*: Tokioka, 1955b, p. 46.

Distribution

New Records: Fiji — Viti Levu: Vuda Point, LWM, July 1979, Holotype QM G12577; Suva Barrier Reef, LWM, July 1980, QM GH66, 70, 71; Sandbank Reef, June 1980, QM GH54. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH76. Palau Is., QM G12677.

Previously Recorded: Great Barrier Reef (Low Is.) — Hastings, 1931. Gilbert Is. — Tokioka, 1967. ?Palmyra, Eniwetok — Eldredge, 1967. ?Palau Is. — Tokioka, 1955b.

Description

Colonies: Colonies vary from extensive investing sheets to small rounded cushions (QM G12577) which occur in large numbers and have probably resulted from lobulation. Colonies are never more than 2 mm thick. The living colonies are 'pinkish-buff', 'flesh colour', 'vinaceous buff', 'salmon colour', 'flesh colour', 'poppy red' and 'scarlet'. In preservative colonies are almost white. The test is densely packed with spicules and there is no superficial bladder cell layer. The surface of the colony is hard owing to the presence of spicules near the surface. There are minute pigment cells mixed with surface spicules but these are absent from other parts of the colony and fade rapidly in preservative. Pigment is absent from the borders of the colony and around the branchial and common cloacal apertures. Orange pigment persists in lacunae in the basal test for a time.

The colonies are firm and hard. The common cloacal cavity is very shallow

(about 0.1 mm deep) and thoracic. The basal test occupies more than half the thickness of the colony. The surface test is also relatively thick and firm.

The spicules are from 0.01 to 0.03 mm, spherical, with numerous, tightly packed, parallel-sided flat-ended rays.

Zooids: These are translucent and orange in fresh material but rapidly fade in preservative. The branchial aperture is 6-lobed and the atrial aperture a wide opening exposing the dorsal part of the branchial sac. There are fine muscle fibres in the thorax and a medium length retractor muscle from the posterior end of the thorax reaching to the middle of the abdomen. There are 4 rows of about 6-8 stigmata.

The abdomen is relatively large (only slightly less than 1 mm). The distal part of the gut loop is flexed only at a slight angle to the vertical oesophagus and stomach. There are only $4\frac{1}{2}$ coils of the vas deferens around the large, spherical ♂ follicle.

Larvae: Larvae are present in the small colonies from Vuda Point. They are of the typical didemnid type. The trunk is 0.5 mm long, and the tail wound the whole way around it. There are 4 pairs of lateral ampullae each side of the 3 adhesive organs, and an ocellus and otolith.

Remarks: The species is characterized by the spherical spicules, limited common cloaca, and relatively few spirals of the vas deferens. It is clear that many specimens of this species have formerly been ascribed to *D. candidum* Savigny. The characters of that species are confused and have included specimens with spicules having many pointed rays, or with a mixture of pointed and blunt-rayed spicules, or with spherical spicules. Van Name (1945) suggested that variation in size and shape of the spicules was associated with the calcareous content of the water and the rigidity of the substrate. This proposition cannot be substantiated and it appears that Van Name's description of investing sheet-like colonies that he referred to *D. candidum* is multispecific and very likely includes specimens of *D. psammatores* (with faecal pellets), *D. moseleyi* (with orange zooids and two sorts of spicules, see above), *D. granulatum* (with fewer conical rays on the stellate spicules), as well as specimens that may be more accurately referred to *D. candidum* Savigny, which have a greater number of vas deferens coils (8) and spicules with numerous rays both pointed and rounded. Van Name (1945) does not appear to have included specimens with exclusively spherical spicules (as in the present species); nor specimens with exclusively stellate many-rayed spicules that Tokioka (1967) assigned to *D. candidum*. Specimens in which there are exclusively spherical spicules (as in the present species) are included in *D. candidum* by Tokioka (1967) and may be a synonym.

Didemnum candidum: Eldredge, 1967, may also refer to a range of species. His diagnosis refers to specimens with 'numerous blunted rays', (questionably synonymized with the present species). In fig. 16 (Eldredge, 1967, p. 216), however, a many rayed stellate spicules described as 'typical' is similar to one type that has been described for *D. candidum* but is not found in the present species.

The presence of spherical spicules in the Gilbert Is. material (Tokioka, 1969) suggests synonymy of specimens with single ♂ follicles with the present species. Those specimens with two ♂ follicles however may be *Polysyncrator recurvatum*, as is possible for Eldredge's (1967) specimens of *D. grande* from Eniwetok and Palmyra (see *P. recurvatum* below).

The colour of the living colonies of *D. proliferum* falls within the same range as other species of this genus, especially *D. moseleyi*, which has the same minute pigment cells and rather diffuse pigment. The small probably lobulated colonies are known for other species (e.g. *Didemnum dispersum* Sluiter, 1909; *D. fraternum* Sluiter, 1909)

but invariably there are other characteristics that distinguish the species. The spicules resemble those of *Polysyncraton recurvatum* but are slightly smaller.

Didemnum psammatodes (Sluiter, 1895)

Leptoclinum psammatodes, Sluiter, 1895, p. 11; 1905, p. 20.

Hypurgon skeati Sollas, 1903, p. 729. Herdman, 1906, p. 337.

Didemnum psammatodes Sluiter, 1909, p. 46; 1913, p. 75. Michaelsen, 1919, p. 14 (part: vars. *guinense*, *skeati*); 1920, p. 22 (part: vars. *skeati*, *typicum*). Hastings, 1931, p. 95. Kott, 1962; p. 326 (part: var. *skeati*). Eldredge, 1967, p. 200.

Didemnum ? psammatodes: Millar, 1956, p. 922.

Hypurgon fuscum Oka, 1931a, p. 287.

Didemnum fuscum: Tokioka, 1953a, p. 192.

Not *Didemnum fuscum* Sluiter, 1909, p. 52.

Didemnum dorotubu Tokioka, 1967, p. 74.

Distribution

New Records: Fiji — Viti Levu: Laucala Bay, experimental mussel raft, July 1979. Great Barrier Reef: Green Is., QM G12496.

Previously Recorded: Indonesia — Sluiter, 1895, 1909, 1913; Sollas, 1903. Sri Lanka — Herdman, 1906. Red Sea, Suez — Sluiter, 1905; Michaelsen, 1920; Kott, 1957a. East African Coast — Michaelsen, 1920; Millar, 1956. Australia (Victoria, Queensland, Torres Strait) — Hastings, 1931; Kott, 1962. Ifaluk Atoll — Eldredge, 1967. Philippines — Tokioka, 1967. China — Tokioka, 1967. Japan — Oka, 1931a; Tokioka, 1953a.

Description

Colonies: These form extensive investing sheets, sometimes swollen into lobes. They are mud- or sand-coloured, depending on the composition of the oval faecal bodies crowded in the test. It is clear from these specimens that these bodies are derived from the particles that are available in the environment although it is not established whether or not they are faecal material or particles absorbed directly into the test from the environment. There are small groups of minute spicules in the test surrounding the branchial apertures. The cloacal canals are shallow and thoracic.

Zooids: These are small and conform in this and other characters with earlier descriptions.

Remarks: Colonies of this species are usually very extensive and are clearly most successful in the competition for space. Generally the species is found where there is no fast current and where there is settlement of very fine particulate matter. The colonies in which the oval test inclusions do occur have a wide Indo-west Pacific range and are sufficiently constant in this and other characters to suggest that specific rank is justified. Therefore those forms that have formerly been regarded as conspecific (see Eldredge, 1967), but which do not contain these inclusions in the test, have not been included in the synonymy set out above.

Didemnum sphaericum Tokioka, 1967

Figs 18b; 27

Didemnum sphaericum Tokioka, 1967, p. 70.

Distribution

New Records: Fiji — Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH127, 128.

Previously Recorded: Palau Is. — Tokioka, 1967.

Description

Colony: The colonies are rather regular circular or oval plates, with rounded borders,

up to 1 cm in diameter but less than 3 mm thick. In life they are 'poppy red' or 'salmon colour'. In preservative the red pigment is present in small cells mixed with spicules in the superficial layer of test. The pigment is absent from an area around each branchial opening. In the Fijian specimens the pigment persists for some time in the preserved material although it is gradually lost. The branchial lobes are lined with spicules. The common cloacal cavity is thoracic and each thorax is enclosed in its own test sheath. The spicules are stellate mostly 0.015-0.03 mm in diameter. Some have 5 to 7 long, almost cylindrical rather blunt-tipped rays in optical section. In others, the rays are shorter, and are supported in basal concavities of greater diameter. The spicules are rather dense throughout the test. The surface layer of test is moderately thin and the basal layer of test is thick.

Zooids: The zooids are orange in preservative and contain spherical pigment cells. They are small, only about 0.6 mm in total length. The atrial aperture is wide exposing the dorsal part of the branchial sac. There is a moderately long retractor muscle that is free from the proximal part of the oesophagus. It extends for most of the length of the abdomen. The gut loop is almost vertical in the thick basal test and the gut loop is flexed upwards only slightly. The stomach is small and there are no apparent subdivisions of the intestine. There is a large testis follicle, pointed on its outer side where the vas deferens begins to spiral and rounded on the side against the gut loop. There are $6\frac{1}{2}$ spirals of the vas deferens.

Remarks: It is likely that the spherical shape of the colonies from the Palau Is. is a result of the limited area for attachment on their algal substrate. The flatter plate-like Fijian colonies are on flat coralline rubble surfaces. It is not known whether the spicules of the Palau Is. specimens included the type with bipartite rays but in all other respects they are identical with those from Fiji. The small zooid size, the length of the retractor muscle, the shape of the testis follicle and the number of vas deferens coils are identical with the structure described by Tokioka. A pointed testis follicle is also present in *Didemnum cuculliferum* but the species differ in other respects. Tokioka's specimens, although they had been in preservative for a long time, retained some colour in the pigment cells. The Fijian specimens appear to have retained their colour in preservative for longer than other species. The close relationship between this species and *D. digestum* is discussed above (see *D. digestum*).

Polysyncraton recurvatum (Sluiter, 1909)

Figs 18c; 28

Didemnum recurvatum Sluiter, 1909, p. 51.

Didemnum ?recurvatum: Millar, 1975, p. 233.

Polysyncraton schillingi Michaelsen, 1920, p. 17.

?Didemnum grande: Van Name, 1918, p. 148; Eldredge, 1967, p. 191.

?Didemnum candidum: Tokioka, 1967, p. 62 (part).

Distribution

New Records: Fiji — Viti Levu: Deuba, on *Laurencia*, September 1979, QM GH58; Serua, LWM, July 1979, QM G12587; Makaluva, LWM, July 1980, QM GH104; Mumbualau, LWM, July 1980, QM GH105; Sandbank Reef, LWM, July 1980, QM GH90; Malevu, LWM, July 1980, QM GH14; Suva Barrier Reef, LWM, July 1980, QM G12588. Great Astrolabe Reef: Yakuve, LWM, July 1980, QM GH101.

This species is the common red to pinkish didemnid found on the underside of rubble, high in the intertidal region on all the Fijian reefs.

Previous Records: Tanzania (Mikinadi Bay) — Michaelsen, 1920. Indonesia — Sluiter, 1909; Millar, 1975. ?Philippines — Van Name, 1918. Eniwetok, Palmyra — Eldredge, 1967. Gilbert Is. — Tokioka, 1967.

Description

In addition to the specimens newly recorded, the following specimen has been examined: *Didemnum recurvatum* ZMA TU474, Holotype, Station 250, Sluiter, 1909.

Colony: The colonies are small and oval or rounded, or they form larger investing sheets up to 3 cm in maximum extent, with spreading white borders. The smaller colonies have central common cloacal apertures and some appear to be lobulating. In life the colonies are 'scarlet', 'poppy red', 'salmon colour', 'flesh colour' and 'vinaceous buff'. The colour may vary in the one colony, but more often each is one uniform colour. The colour differences are caused by varying densities of pigment cells. In preservative the colonies are always the same dirty, brownish-white colour owing to the dark 'hazel' coloured pigment cells scattered mainly in the superficial layer of bladder cells. Elsewhere, spicules are dense throughout the test. In this species the red pigment of the living colonies changes to brown in preservative, and is not lost from the colony. The thoracic cloacal cavity is of variable depth. Both the upper and basal layers of test are relatively thick (0.2 mm and 0.5 mm, respectively) and firm. The thoraces of zooids usually cross the cloacal cavity separately although sometimes there are clumps where surface and basal test is continuous around a group of zooids. In preserved colonies the branchial apertures are conspicuous as dark points or star-shaped openings interrupting the otherwise dense spicules. When zooids are contracted and withdrawn from the surface the position of each aperture is marked by a dimple in the otherwise smooth surface. Common cloacal apertures are wide sessile openings with less dense spicules around their borders. The spicules are spherical, with numerous flat-ended parallel-sided rays 0.01-0.04 mm in diameter.

Zooids: The zooids are large, up to 1.5 mm long. In preservative they are an opaque dark buff colour with brown and white cells in the body wall. The white opaque cells persist and are very characteristic. There are 10 stigmata in each of the four rows. A circular lateral organ projects from the body wall on each side of the endostyle and opposite the third row of stigmata. There is a long narrow neck, about one third of the body length, between the thorax and the distal part of the abdomen which is bent at right angles to the long axis of the zooid. A retractor muscle of medium and variable length extends from the proximal end of the oesophageal neck and sometimes extends to overlap the distal part of the gut loop where it is bent at right angles to the vertical oesophagus. The gut loop is long and the lumen of the gut quite narrow. Divisions of the gut posterior to the stomach are not conspicuous. The testis is divided into two to four lobes and the vas deferens winds around them $4\frac{1}{2}$ times. No gonads were present in colonies collected in September 1979.

Larvae: Larvae are present in the basal test of colonies collected in July 1980. The large trunk is 0.87 mm long and the tail is wound half way around it. There are 4 cylindrical ampullae along the lateral line on each side of the 3 small median adhesive organs which are set close together.

Remarks: The post mortem colour of this species is distinctive. Living specimens cannot be readily separated from *D. moseleyi*, *D. granulatum*, *D. cuculliferum*, *D. sphaericum* and *D. proliferum*, all of which have the same range of colours in life. The spicules can be used to distinguish the species from all except *D. proliferum* which has similar spicules in the same size range. Colonies of *D. proliferum*, are harder than those of the present species and have a more restricted common cloaca. Sometimes the surface test of the present species is raised into slight swellings where clumps of zooids underlie it, thus providing a further distinction that may be useful in the field. Tokioka (1967) has questionably synonymized his *D. candidum* with this species, and Millar (1975) discussed the possibility that *D. grande*: Van Name, 1918, was

synonymous. The possibility that *D. grande*: Eldredge, 1967, some specimens of *D. candidum*: Tokioka, 1967, from the Gilbert Is. and some of the specimens assigned to *D. grande* by Van Name (1918) are synonyms of the present species should not be overlooked, since the cloacal cavities, spicules, branchial sacs, gut loop and colonies and their pigmentation are the same and frequently there are no more than two ♂ follicles in zooids of the present species.

The holotype, ZMA TU474, agrees with those in the present Fijian collections in all respects except that the retractor muscle was not distinguished. Sluiter's holotype does have two ♂ follicles as in Millar's (1975) material (Fijian specimens have 2-4 ♂ follicles).

Millar (1975, p. 235) has observed that 'Sluiter (1907) alone described 25 new species (of Didemnidae) but without clearly distinguishing them'. Nevertheless, without seeing the type specimen of *D. recurvatum* Sluiter, and without the information that it did contain two ♂ follicles, he had tentatively (but accurately) assigned his specimens to this species. This must be a testimonial to the accuracy of Sluiter's seemingly ambiguous descriptions and his (Millar's) capacity to observe and interpret this difficult group. The species is distinguished by its spherical spicules, absence of an atrial tongue, small number of ♂ follicles, the long, narrow gut loop, the number of vas deferens spirals and the opaque zooids with white corpuscles that persist in preservative.

In view of its common occurrence and wide geographical range it is surprising that there are not more records of this species.

Polysyncraton doboense (Sluiter, 1913)

Figs 18d-f; 29

Polysyncraton doboense Sluiter, 1913, p. 77.

Distribution

New Record: Fiji — Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH143.

Previously Recorded: Aru Is. — Sluiter, 1913.

Description

Colony: Only a fragment of a colony (about 2 cm in length) is available. It is 3.0 mm thick and is solid with very firm test. Its colour in life was 'poppy red'. In preservative it is white with small dark pigment cells scattered amongst the spicules in the surface of the colony, and in reservoirs in the thick basal test. The common cloacal cavity is shallow, at thoracic level. The surface test is very thin. Spicules are dense throughout the test and there is no superficial layer of bladder cells. Spicules fill, but do not outline, the 6 branchial lobes. There are faint fine straight lines in the superficial layer of test that divide the surface into irregular diamond-shaped areas with branchial apertures more or less in the centre of each of these areas. These lines are visible only because they interrupt the densely packed spicules. They may therefore be vessels in the superficial test. They are no more than 0.05 mm in diameter, and are reminiscent of similar markings in *Lissoclinum patellum* (see Kott, 1977).

The spicules up to about 0.04 mm diameter, have about 15 short, conical, pointed rays projecting from a central sphere. Some spherical spicules with blunt-ended rays are generally of lesser diameter and may have been developed from the stellate forms by loss of the pointed rays. The stellate spicules do not vary very much in diameter. Scanning electron micrographs do not show the same crystalline structure in the spicules rays as is usual.

Zooids: The zooids are each embedded in a layer of test that is surrounded by the cloacal cavity. They are about 1.5 mm long, from branchial aperture to the pyloric end of the stomach, and the gut loop, distal to the stomach is curved almost

horizontally to the left. The branchial aperture has 6 pointed lobes and is on a short siphon with conspicuous circular sphincter muscles. There are also fine longitudinal thoracic muscles. The atrial opening is extensive, and there is a long, forked lip from the upper border of the opening. There are 8 long rectangular stigmata in each row. The oesophageal neck is rather long and a solid but only moderately long retractor muscle is free from mid-oesophageal level. The stomach is relatively small and pyriform. The voluminous gut loop curves upwards to the left but there is no extra upward flexure in the distal part of the loop. The testis is large and divided into two follicles. The vas deferens spirals around these $6\frac{1}{2}$ times.

Remarks: The specimen agrees with Sluiter's (1913) description in every aspect except that it has two rather than four testis follicles. Variations of this magnitude occur in the genus, and may do in this species. In view of the similarity in other characters it seems appropriate to assign the specimen to Sluiter's species.

The species is distinguished from *P. recurvatum* by the very firm texture of its colony, larger spicules, very large atrial lip, absence of white corpuscles in the zooid, mid-oesophageal origin of the retractor muscle and voluminous gut (in contrast with the narrow diameter and longer loop of the gut in *P. recurvatum*).

Leptoclinides madara Tokioka, 1953

Fig. 30

Leptoclinides madara Tokioka, 1953a, p. 200.

Leptoclinides rufus: Eldredge, 1967, p. 220.

Leptoclinides marmoratus: Millar, 1975, p. 235 (part: specimens from Koh Mesan — Koh Chuen and Banda, fig. 24).

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, LWM, July 1979, QM G12459.

Previously Recorded: Japan (Sagami Bay) — Tokioka, 1953. Indonesia — Millar, 1975. Hawaii — Eldredge, 1967. Intertidal to 50 m.

Description

Colonies: Two large colonies, one solid black and one brick-red were found adjacent to one another. In preservative (4% formalin) the black colour is lost and the colony becomes translucent with faint orange pigmentation in the surface test. The brick-red specimen has retained more of its colour in preservative and is a light, translucent orange-red. The pigment cells were found to be more densely arranged in the brick-red colony that retained more of its colour. No other difference between the two colonies was detected. The pigment cells are present in the superficial bladder cell layer. They are large, ribbon-like, fusiform, branched, or irregularly pyriform, up to 0.007 mm in width and 0.07 mm in greatest extent. They are filled with spherical granular particles. There is a layer of spicules below the bladder cell layer, extending through it to the surface around the branchial siphons which appear at the surface as white dots. The spicules and the pigment cells become more sparse toward the base of the colony and are absent altogether below the common cloacal cavity. There are large spherical patches of black or reddish pigment in the surface of the basal test (below the cloacal cavity) in some parts of the colony. The spicules are also absent from around the borders of the large, conspicuous, and apparently almost sessile common cloacal apertures.

The spicules are large and stellate, from about 0.04 to 0.07 mm with 8-12 sharply-pointed rays in optical section.

Zooids: The zooids are about 2 mm long. The relaxed thorax is larger than the abdomen. The branchial aperture has 6 well-defined lobes. The atrial siphon is long and extends posteriorly from the posterior third of the dorsal surface. There are long



Fig. 19. a, *Leptoclinides ocellatus* (QM GH61) stellate spicules with long attenuated rays, 0.03-0.05 mm (scale 0.005 mm); b, *Leptoclinides rufus* (QM G12575) stellate spicules with variable numbers of conical rays, some with basal concavities, 0.02-0.05 mm (scale 0.05 mm).

circular sphincters around both apertures. The atrial sphincter is around the distal half of the siphon. When the zooid is contracted the walls of the siphon extend into bilateral pouches just behind the sphincter muscle. There are 8 longitudinal thoracic muscles on each side. A circular to transversely oval lateral organ is depressed into the body wall opposite the middle of the third row of stigmata. There are 8 elongate oval stigmata in each of the four rows. The gut forms a simple elongate loop, although the rectum may be bent over into the proximal part of the atrial siphon. There is a conspicuous gastro-intestinal gland. A rosette of 4 or 5 radiating ♂ follicles is covered by 6 coils of the vas deferens.

Larvae: Neither testes nor ova are mature in the present colonies. Millar (1975) has reported embryos 0.45 to 0.55 mm with 3 adhesive organs, single dorsal and ventral ampullae and 3 pairs of broad lateral ampullae. Although Eldredge (1967) records 4 pairs of lateral ampullae his fig. 17c shows a well developed larva of 0.725 mm with the same adhesive apparatus as in Millar's specimens.

Remarks: The species is characterized by its large and variably shaped pigment cells, very large spicules, relatively small number of ♂ follicles and long atrial siphon with sphincter muscle and pouches.

The colour of the preserved colonies ranges from white with blue markings (Tokioka, 1967), warm grey to deep blue black (Millar, 1975) and tan, sometimes with orange streaks (Eldredge, 1967). Generally the pigment is not evenly distributed, although the even colour of the present colonies in life suggests that sometimes irregularities may result from uneven loss of pigment from preserved specimens. Apparently there is also some variation in the distribution of spicules, which in some of the Hawaiian specimens (Eldredge, 1967) have obscured the bladder cell layer, although in all other specimens they are confined to a layer beneath the bladder cells or are occasionally absent (Eldredge, 1967).

The larvae have more ectodermal ampullae than those of *L. rufus* (see Kott, 1962) and *L. marmoratus*: Millar, 1975, from Jolo (?<*L. rufus*).

Leptoclinides ocellatus (Sluiter, 1909)

Figs 19a; 31

Polysyncraton ocellatum Sluiter, 1909, p. 73.

Distribution

New Records: Fiji — Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH61.

Previously Recorded: Indonesia — Sluiter, 1909.

Description

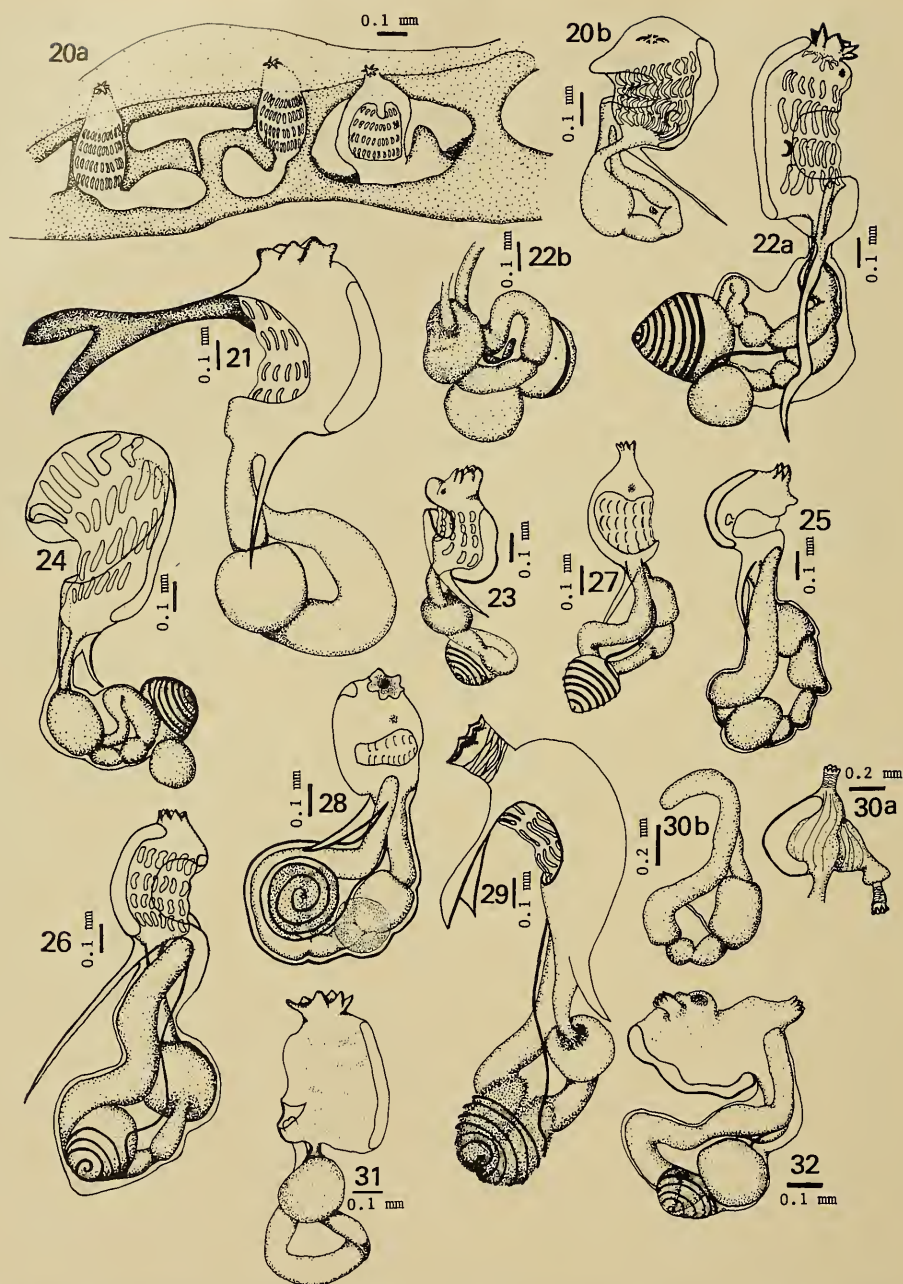
Colony: The colony is extensive. The surface is uneven, marked by furrows and rounded prominences, up to 5 mm thick at their highest point. The test is firm, tough and gelatinous. There is a thick superficial layer of bladder cells above a layer of spicules, at the level of, and interrupted by, the branchial siphons so that the zooids, which are brown in preservative, are seen from the surface as brown dots interrupting the white spicules. There are large spherical brown globules randomly distributed in the bladder cell layer that are about the same diameter (about 0.3 mm) as the circular areas over the zooids. The living colony was a greenish black sheet stretched over a rocky substrate.

Common cloacal cavities with spicule-free borders are present in the centre of each rounded swelling of the surface of the colony. The zooids lie horizontally in the surface test, their atrial apertures opening directly into the large cloacal cavity that occupies the centre of each rounded swelling. Only very rarely do test connectives cross the cavity to anchor surface to basal test. More often the cavities are uninterrupted, the surface and basal test being connected only around the periphery of the cavity. The basal test is usually paper thin below the cloacal cavity but becomes thicker around its periphery and beneath any test connectives that cross it. A layer of bladder cells is also present in the floor of the cloacal cavity, where the basal test becomes thicker. Spicules are sparse around the zooids, in the roof of the cloacal cavity and in the basal test. They are moderately dense only in the surface test beneath the bladder cell layer and in test connectives. They are large (0.03-0.05 mm diameter) stellate, with 7-9 long, narrow and pointed rays in optical section. Spicules do not outline either the branchial lobes or atrial aperture. The distal half of each ray appears attenuated and narrows rather abruptly from the basal section. This attenuated distal half of the rays is often sheared off the base, leaving a flat-topped stump.

Zooids: These are about 1.2 mm long. The branchial lobes are conspicuous and pointed. The atrial aperture, from the posterior part of the thorax, is two-lipped and does not appear to have the cylindrical siphon characteristic of most species of this genus. The two lips may be withdrawn to expose much of the branchial sac and the distal portion of the rectum and the two-lipped anal opening.

About 10 fine muscle bands extend along the thorax. There are 12 stigmata in each of the four rows. The oesophagus is short, the gut loop distal to the stomach is wide and bent upwards. A mass of glandular vesicles is present around the intestine and proximal part of the rectum. There are no gonads developed in these zooids.

Remarks: Although gonads are not developed in these specimens, the development of the common cloacal cavity and orientation of the zooids to it is characteristic of the genus. The specimen has been assigned to *L. ocellatus* on the basis of similarities in the outer appearance of the colony, the large globular dark masses in the superficial layer, the size and form of the zooids and their musculature and branchial sacs. However, the spicules of the present specimen are vastly different from those described for the



Figs 20-32. 20, *Didemnum albopunctatum* (QM G12591): a, cross section of colony showing zooids and cloacal cavity; b, zooid. 21, *Didemnum chartaceum* (QM GH55), zooid. 22, *Didemnum cuculliferum* (QM G12594): a, zooid; b, gut loop with gonads and glandular body. 23, *Didemnum digestum* (QM G12614), zooid. 24, *Didemnum granulatum* (QM G12586), zooid. 25, *Didemnum moseleyi* (QM G12589), zooid. 26, *Didemnum proliferum* (QM G12577), zooid. 27, *Didemnum sphaericum* (QM GH127), zooid. 28, *Polysyncrator recurvatum* (QM GH90), zooid. 29, *Polysyncrator doboense* (QM GH143), zooid. 30, *Leptoclinides madara* (QM G12459): a, thorax; b, gut. 31, *Leptoclinides ocellatus* (QM GH61), zooid. 32, *Leptoclinides rufus* (QM G12615), zooid.

Indonesian material and the specimens may be found not to be conspecific when additional material can be examined.

Leptoclinides reticulatus (Sluiter, 1909)

Didemnum reticulatum Sluiter, 1909, p. 60; 1913, p. 74.

Leptoclinides reticulatus: Hastings, 1931, p. 92. Kott, 1962, p. 285; 1972a, p. 18; 1972b, p. 180.

Didemnoides tigrinum Oka, 1927, p. 498..

Leptoclinides tigrinum: Tokioka, 1953b, p. 2; 1954c, p. 70.

Distribution

New Records: Fiji — Great Astrolabe Reef; Dravuni, LWM, July 1980, QM GH63.

Previously Recorded: Japan (Honshu) — Oka, 1927; Tokioka, 1953b, 1954c. Australia (Low Is., Great Barrier Reef) — Hastings, 1931. Circum Australia — Kott, 1972a, b. Indonesia — Sluiter, 1909.

The records suggest that this species has a wide latitudinal range to the north and to the south of the equator.

Description

Colony: The colonies form solid sheets that are streaked with black and yellow pigment patches. One of the colonies was 'indian yellow' when living, but in preservative has the usual fusiform and branched, finely tapering, black pigment cells in addition to the patches of yellow-orange pigment in spherical and oval cells. The pigment cells are present amongst the superficial bladder cells and the single layer of stellate spicules at the level of the branchial siphons. The spicules are very sparse in the remainder of the test. The zooids are often horizontal above the extensive cloacal cavity.

Zooids: The zooids open directly into the common cloacal cavity by a posteriorly-directed atrial siphon. They are of the usual form with about 10 stigmata in each row. They are actively budding in the Fijian specimens and no gonads were seen.

Remarks: The spindle-shaped, often branched pigment cells distinguish this species from *L. rufus* (with oval pigment cells) and *L. madara* (with ribbon-like pigment cells). Its black and yellowish markings are distinctive. It is a common species in temperate as well as tropical waters.

Leptoclinides rufus (Sluiter, 1909)

Figs 19b; 32

Polysyncraton rufum Sluiter, 1909, p. 72.

Leptoclinides rufus: Tokioka, 1952, p. 92. Kott, 1962, p. 286.

Not *Leptoclinides rufus*: Eldredge, 1967, p. 220. (<*L. madara*, above).

Leptoclinides lissus Hastings, 1931, p. 93. Millar, 1963, p. 704.

?*Leptoclinides marmoratus*: Millar, 1975, p. 235 (part: specimens from Jolo Is., fig. 25).

Distribution

New Records: Fiji — Viti Levu, July, 1979: Makaluva, LWM, QM G12575; Suva Barrier Reef, LWM, QM G12615.

Previous Records: Indonesia — Sluiter, 1909; Tokioka, 1952. Queensland — Hastings, 1931; Kott, 1962. N.S.W. — Millar, 1963. Phillipines — Millar, 1975.

Description

Colony: The colonies in the present collection were, in life, cream-brown. The preserved specimens are translucent and slightly orange, especially around the borders of the colonies where small spherical pigment cells are found more densely. There is a

superficial layer of pigment cells and spicules are found beneath this layer. The spicules are from 0.02 to 0.05 mm in diameter with 7-9 conical pointed rays in optical section. The distal part of the ray in some of the spicules is supported in a basal section of greater diameter. The common cloacal apertures are large and oval.

Zooids: These are colourless in the preserved specimens. There are 6 branchial lobes with a fairly long muscular sphincter around the siphon. The atrial siphon projects posteriorly, but is rather short and its sphincter is not conspicuous. There are about 8 longitudinal thoracic muscles. The shallow lateral organ is opposite the third row of stigmata. The gut forms a simple vertical loop. Only 3 ♂ follicles could be detected in these specimens. The vas deferens spirals 6 times.

Larvae: No mature gonads or larvae present in these colonies. Previous records are of a larval trunk 0.7-0.8 mm long (Kott, 1962, Millar, 1975). There are only 3 pairs of ectodermal ampullae.

Remarks: This species is distinguished from others by its spherical pigment cells. Its lesser number of larval ampullae, shorter atrial siphon and smaller spicules also distinguish it from the closely related *Leptoclinides madara*. *Leptoclinides reticulatus* (see Kott, 1962) has even smaller spicules, and 4 pairs of larval ampullae.

Eldredge (1967) and Millar (1975) have not separated most of the Indo-west Pacific *Leptoclinides* spp. from one another. Although the colour of both living and preserved specimens and the distribution of the spicules appears to be highly variable, the size of the spicules and the form of the pigment cells appear to provide reliable specific characters.

Trididemnum discrepans (Sluiter, 1909)

Figs 35, 36

Leptoclinum discrepans Sluiter, 1909, p. 77.

Didemnopsis jolense Van Name, 1918, p. 147.

Trididemnum savignii var. *jolense*: Tokioka, 1967, p. 82.

Distribution

New Records: Fiji — Viti Levu: Malevu, July 1979, QM G12475-7; July 1980, QM G12922. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH121. Great Barrier Reef — Green Is., on *Zostera*, August 1979, LWM, QM G12477.

Previous Records: Indonesia — Sluiter, 1909. Philippine Is. — Van Name, 1918; Tokioka, 1967. Palau Is., Gilbert Is. — Tokioka, 1967. Florida — Tokioka, 1967.

Description

Colony: The present colonies are 0.5-2.0 cm in diameter and about 0.5 cm high, regularly hemispherical or slightly irregular and lobed (QM G12477), and sessile. The rounded surface is uppermost. The test is firm, translucent, beige to black, varying with the density of black pigment in elongate or branching long narrow pigment bodies that fit in the interstices between the very large bladder cells that occupy most of the test. The pigment bodies are made up of small spherical or irregular particles that appear to be joined together into strands. There are also minute clear morulae scattered through the test. There are no calcareous spicules. There are two to three sessile open cloacal apertures on the upper border of the colony that are made more conspicuous by dense pigment in the surrounding test. Zooids are relatively sparse, but evenly spaced and open all around the upper surface. Common cloacal canals are thoracic.

Zooids: These are about 1.5 mm long. There is some dark pigment in the anterior part of the body wall, that extends posteriorly along either side of the dorsal and ventral mid-lines. The thorax and oesophageal neck together represent about half of

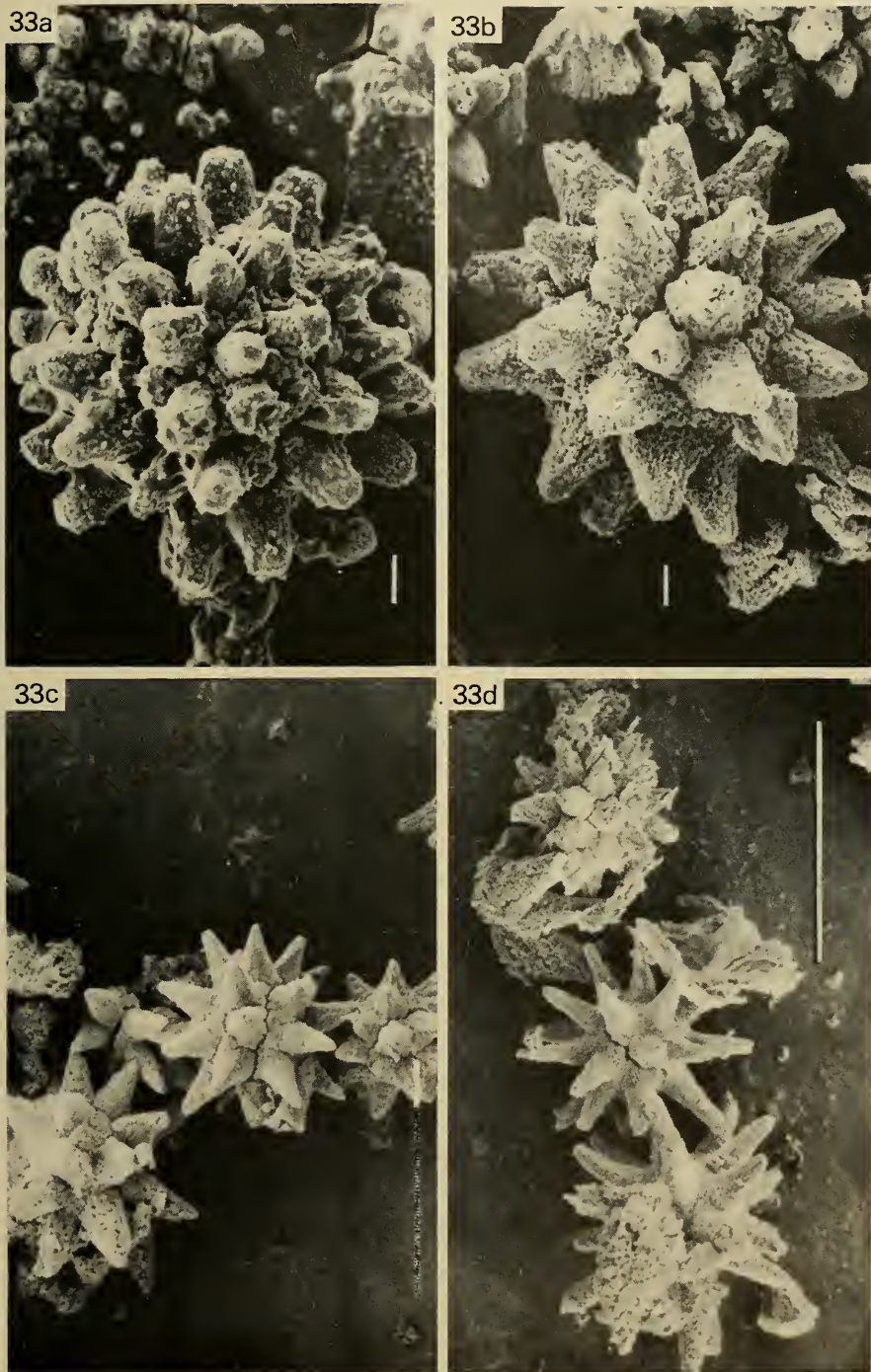


Fig. 33. a,b, *Trididemnum savignii* (QM G12618) stellate spicules with numerous short conical rays, 0.04-0.97 mm (scale 0.005 mm) c, d, *Trididemnum cerebriforme* (QM G12574) stellate spicules with long pointed rays, 0.03-0.05 mm (Scales c, 0.005 mm; d, 0.05 mm).

the zooid length and the abdomen the remainder. The branchial lobes are rounded, on a very short siphon. A short horizontally-directed atrial siphon extends from the middle of the dorsum. There are 3 rows of 10 stigmata, which become shorter at the dorsal and ventral end of each row. A medium to long retractor muscle extends from the proximal part of the oesophageal neck to one- to two-thirds of the length of the abdomen. The gut loop is vertical and open at the pole. There are $6\frac{1}{2}$ coils of the vas deferens around the undivided σ follicle.

Larvae: These are present in the Fijian colonies. They are large (about 1.3 mm), with 4 paired lateral ampullae, 3 median adhesive organs, an otolith and ocellus. The larval test appears frothy and contains the very large bladder cells that are characteristic of the adult colony.

Remarks: The bladder cells, pigment cells, morula bodies, and the relatively large abdomen of the present species are distinctive. The species does resemble aspicular colonies of *T. savignii*, with similar pigment bodies. The rounded shape of the colony and the larger zooids and pigment cells and bladder cells distinguish it.

Trididemnum savignii (Herdman, 1886)

Figs 33a, b; 37

Didemnum savignii Herdman, 1886, p. 261. Van Name, 1902, p. 358.

Trididemnum savignii: Van Name, 1921, p. 314; 1924, p. 23; 1930, p. 428; 1945, p. 100. Hastings, 1931, p. 91. Pérès, 1949, p. 184; 1951, p. 1056. Tokioka, 1953a, p. 197; 1962a, p. 3. Eldredge, 1967, p. 178.

Not *Trididemnum savignii*: Kott, 1966, p. 285; 1975, p. 9. Tokioka, 1967, p. 80 (< *T. cerebriforme*, see below).

Trididemnum planum Sluiter, 1909, p. 42.

Trididemnum natalense Michaelsen, 1920, p. 3. Hastings, 1931, p. 92. Kott, 1962, p. 278.

Distribution

New Records: Fiji — Viti Levu: Malevu, LWM, July 1979, QM G12618. Deuba, LWM, September 1979, QM GH57. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH99.

Previous Records: Atlantic — Herdman, 1886; Pérès, 1949, 1951; Van Name, 1902, 1921, 1924, 1930, 1945; Berrill, 1932. West Indian Ocean — Michaelsen, 1920. Japan — Tokioka, 1953a, 1962a. Hawaii — Eldredge, 1967. Australia (Queensland) — Hastings, 1931; Kott, 1962; (South Australia) — Kott, 1962, 1975; (Western Australia) — Kott, 1962.

Description

Colony: The living colonies are smooth-surfaced, dark-pigmented and gelatinous. The preserved colonies are grey or grey-brown. There is a superficial layer of bladder cells. Irregular fusiform or oval pigment cells are present in the thoracic layer of test where there are also occasional patches of spicules. There is a distinct layer of spicules in the upper part of the basal test, lining the floor of the thoracic cloacal cavity. Spicules are absent from the remainder of the basal test. They are large (0.04–0.07 mm diameter) with 9–14 conical pointed or rounded rays in optical section.

Zooids: The zooids with contracted thorax are slightly more than 1 mm long, the thorax and abdomen of more or less equal length. They are opaque, with dark brown pigment in the body wall, especially anteriorly. There is often, but not always, an endostylar pigment cap. There are 6 distinct branchial lobes. The atrial aperture is on

a very short siphon from the middle of the thorax. There is a short to medium-length retractor muscle from the posterior end of the thorax. There are about 8 stigmata in each of the three rows.

The gut loop is curved ventrally, and there are $7\frac{1}{2}$ coils of the vas deferens around the single ♂ follicle.

Larvae: These are not present in the Fijian material (see Kott, 1962).

Remarks: There remains confusion regarding the characters of this species and the closely related *T. cerebriforme* which has similar zooids. The smooth surface, flat colony, thoracic cloacal cavity, the darkly pigmented test, the absence of a distinct and continuous layer of spicules in the test above the zooids and the presence of a distinct layer of spicules in the floor of the cloacal cavity appear to distinguish the Fijian and Australian specimens from *T. cerebriforme*. There are also some differences in the spicules (see *T. cerebriforme* below).

Specimens from Hawaii (Eldredge, 1967) and Japan (Tokioka, 1953a) are unusual in this species. Although their cloacal cavities are thoracic, the colour of the colonies, and the distribution of the spicules (especially those at the surface of the colony that are in a continuous layer and form rounded swellings over the top of the zooids) are more reminiscent of *T. cerebriforme* than of the present species. *T. savignii*: Tokioka, 1967, from various mid-Pacific locations, is possibly *T. cerebriforme* (see below).

No reliable distinguishing characters have been identified to separate the west Indian Ocean *T. natalense* from the present species in either the Atlantic or Pacific Oceans. The number of stigmata, coils of the vas deferens, density and distribution of spicules are all variable and all populations appear to have overlapping ranges of these variable characters. There is also some variation in the length of the retractor muscle which is sometimes twice the length of the thorax (Michaelsen, 1920), about the same length as the thorax (QM G12618), or very much less than the length of the thorax (see Pérès, 1949; Eldredge, 1967; Tokioka, 1953a). In all these specimens, the origin of the retractor muscle is from the posterior end of the thorax. Only in the West Indian populations (Van Name, 1921, 1945) does the retractor muscle originate from half way down the oesophageal neck. This may indicate some isolation of populations but does not at this stage appear to justify a separate specific rank for populations in the western Atlantic.

Trididemnum cerebriforme Hartmeyer, 1913

Figs 33c, d; 38

Trididemnum cerebriforme Hartmeyer, 1913, p. 139. Michaelsen, 1924, p. 341. Millar, 1955, p. 178; 1962, p. 170. Kott, 1962, p. 275; 1972c, p. 247; 1972d, p. 47; 1975, p. 10; 1976, p. 64.

Not *Trididemnum cerebriforme*: Kott, 1972b, p. 178.

Not *Trididemnum savignii*: Tokioka, 1967 (part: ?not Japanese colonies).

Trididemnum luderitzi: Kott, 1957a, p. 139. ?Michaelsen, 1930, p. 506.

Distribution

New Records: Fiji — Viti Levu: Makaluva, LWM, July 1979, QM G12574; Sandbank Reef, June 1980, QM GH6. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH64, 72, 75.

Previously Recorded: New Zealand — Michaelsen, 1924. South Africa — Hartmeyer, 1913; Millar, 1955, 1962a. Southern Arabia — Kott, 1957a. Circum-Australia — Kott, 1962, 1972c, 1972d, 1975, 1976. Philippine Is., Palau Is., Mariana Is., Hawaii — Tokioka, 1967.

Description

Colony: An irregular rather brittle colony, translucent and whitish, often covered with, or with patches of green (prokaryotic?) cells on the surface. Living colonies may be white or 'straw yellow' or green depending on the distribution of these green cells. One colony is 'chrome yellow' with diffuse pigment in the bladder cell layer. Zooid openings are evenly spaced over the surface. Around the borders of the colony furrows tend to separate the surface into lobes. There is a thin superficial layer of bladder cells. Beneath this there is a continuous layer of spicules which form a swelling over the anterior end of each zooid. Spicules are present more sparsely in the remainder of the test and decrease in density toward the base of the colony. The spicules are large (0.03-0.05 mm) with 7-9 pointed rays in optical section. The common cloacal cavity is primarily posterior abdominal, extensive and the basal test is rather thin. Common cloacal apertures are conspicuous.

Zooids: These are slightly less than 1 mm long and contain black-brown pigment in the body wall, especially over the abdomen and around the anterior part of the thorax. There is an endostylar pigment cap. Zooids have 8-10 stigmata and $6\frac{1}{2}$ - $8\frac{1}{2}$ coils of the vas deferens. The branchial siphon is well developed with a long circular sphincter muscle and 6 distinct branchial lobes. The atrial siphon is also long, from the posterior third of the thorax. There is a short to medium length retractor muscle from the posterior end of the thorax that extends only part of the distance down the abdomen. Larvae are present in colonies from Sandbank Reef in June 1979 (QM GH6).

Remarks: The species is distinguished from *T. savignii* by the posterior abdominal cloacal cavity, the distribution of pigment and spicules, and by the slightly smaller spicules with fewer rays that are present in *T. cerebriforme*. The complicated anastomosing and folding of the colony that is observed in many specimens has not developed in the present small colonies. The milky white appearance of the colonies, the posterior abdominal cloacal cavity, the size of the spicules, their form and their distribution all indicate that specimens of *T. savignii*: Tokioka, 1967, from the mid-Pacific are synonymous with the present species. The larger Japanese colonies which Tokioka (1967) believes to be conspecific do not appear to belong to either of these species.

In *Trididemnum luderitzi* Michaelsen, 1919, from West Africa the cloacal cavities extend posterior to the zooids as in the present colonies and the spicules and spicule distribution are similar. It is distinguished by its smaller zooids and the smaller number of stigmata in each row (see Michaelsen, 1919). *Trididemnum luderitzi*: Michaelsen, 1930, from Western Australia, with 8 stigmata in each row, may be synonymous with the present species.

The association with plant cells appears to be a non-obligatory one, unlike other species of the family (Kott, 1980) in which these cells are always present. Unlike the present species, the eastern Pacific and Atlantic species *Trididemnum solidum* has a very thick surface layer of plant cells (see Lewin and Cheng, 1975) that may also be an obligatory associatory.

Trididemnum clinides Kott, 1977

Trididemnum clinides: Kott, 1977, p. 617; 1980, p. 5.

New Records: Malevu, behind *Sargassum* zone on reef crest, June 1980, QM GH17; under cascades July 1980, QM GH13. Namanda, under cascades, July 1980, QM G12872. Mumbaulau, LWM, July 1980, QM GH144. Great Astrolabe Reef (Dravuni), LWM, July 1980, QM GH91.

Remarks: The soft colonies previously described have been taken from the western fringing reefs where they are found enmeshed in the algal mat under the cascades.

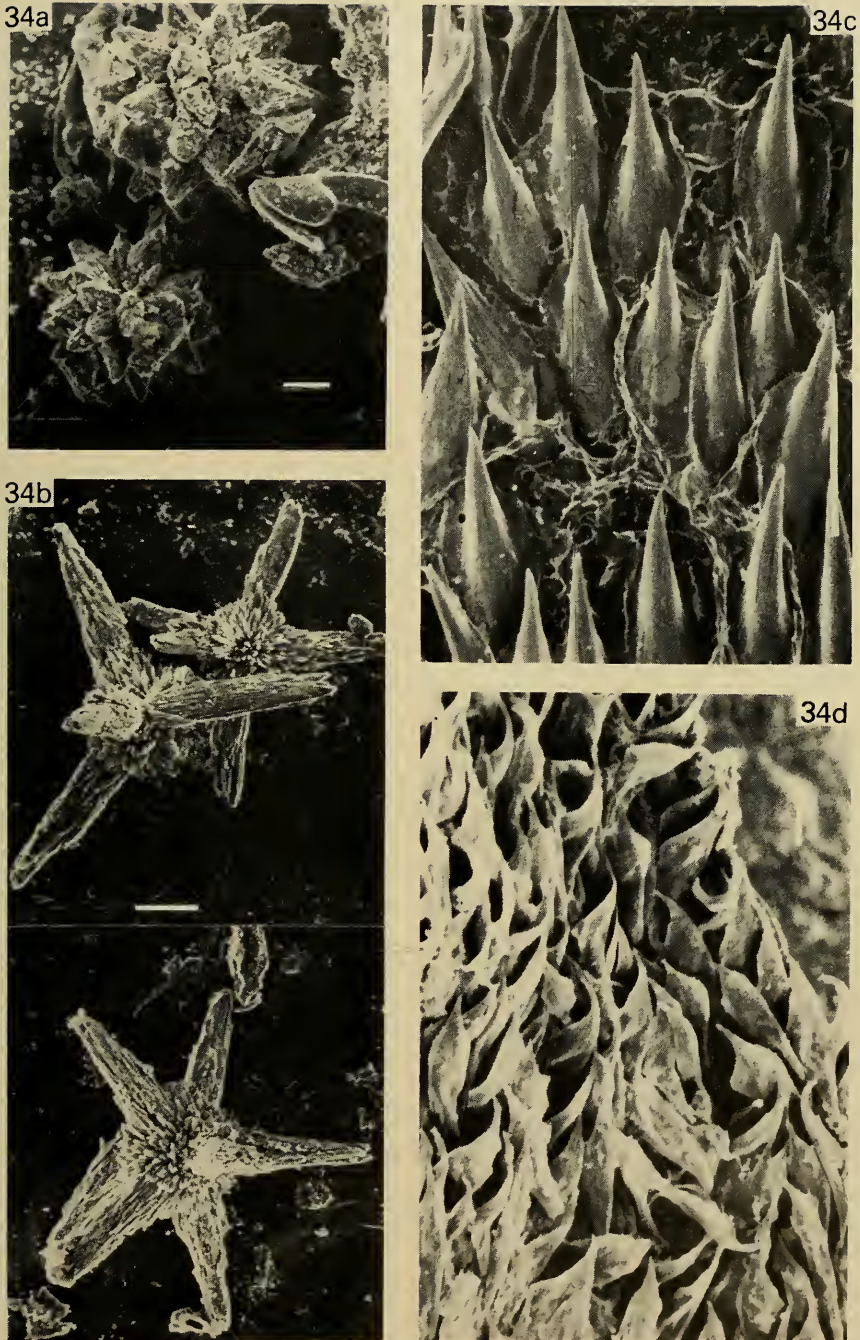


Fig. 34. a, *Trididemnum spiculatum* (QM G12585) stellate spicules with numerous short conical rays, 0.02-0.03 mm (scale 0.005 mm); b, *Echinoclinum pacificensis* (QM G12584) spicules with four to five long pointed rays, maximum length of rays 0.03 mm (scale 0.005 mm); c, *Pyura sacciformis* (QM G12716) branchial spines (scale 0.05 mm); d, *Microcosmus exasperatus* (QM G12701) branchial spines (scale 0.01 mm).

Larger (up to 2 cm long), firmer colonies were taken at Mumbualau and the Great Astrolabe Reef. In life these colonies are 'blackish slate'. Freshly preserved material is green, but quickly fades to white as the plant cells, embedded in the test, lose their colour. The slate colour is caused by black pigment that is contained in large rounded reservoirs in the basal test in the preserved material.

The retractor muscle is of variable length. It always arises from the posterior end of the thorax, and is often very short, but may sometimes extend the whole length of the very small abdomen with its short oesophagus.

Trididemnum cyclops Michaelsen, 1921

Trididemnum cyclops Michaelsen, 1921, p. 19: Kott, 1980, p. 10 and synonymy.

Records: This small species is usually present in rather cryptic habitats over the reef flats. It was less common in July 1980 than it had been the previous year.

Trididemnum paracyclops Kott, 1980

Trididemnum paracyclops Kott, 1980, p. 12 and synonymy.

New Records: Mumbualau, LWM, July 1980, QM GH5. Suva Barrier Reef, LWM, July 1980, QM G12912. Makaluva, LWM, July 1980, QM G12911 (with larvae). Namanda, LWM, July 1980, QM G12910. Malevu, LWM, June 1980, QM GH7; July 1980, QM G12913. Great Astrolabe Reef (Dravuni), LWM, July 1980, QM G12908 (with larvae), G12909.

Remarks: Large investing sheets of this species were conspicuous over wide areas of the reef flats, lining pools and in other non-cryptic locations. The black pigment outlining the edge of the colony in the living specimens is quite distinctive.

Trididemnum nubilum Kott, 1980

Trididemnum nubilum Kott, 1980, p. 9.

New Record: Sandbank Reef, LWM, June 1980, QM G12927.

Remarks: This Fijian record represents the first outside the Philippines for this small inconspicuous species. However it has also been taken recently from Lizard Is. (June 1980, coll. PK). It differs from *T. strigosum* principally in its smaller many-rayed spicules (up to 0.05 mm diameter) and very long retractor muscle.

Trididemnum strigosum Kott, 1980

Trididemnum strigosum Kott, 1980, p. 8.

New Records: Malevu, behind *Sargassum* zone on reef crest, June 1980, QM GH18; Great Astrolabe Reef (Dravuni), LWM, July 1980, QM GH84.

Remarks: These records are the first from Fiji of this species thought to be an endemic Philippine species. It has embedded plant cells, a small zooid (0.6 mm), an incised atrial aperture and a stalked projecting lateral organ. It is distinguished from *T. nubilum* principally by its large spicules (0.05-0.08 mm diameter) with few (7) conical rays. The spicules are not quite so dense in the Fijian specimens as had been previously reported (Kott, 1980).

Trididemnum spiculatum Kott, 1962

Figs 34a; 39

Trididemnum spiculatum Kott, 1962, p. 281 (part: specimens from Rottnest Is. and Wreck Bay).

Distribution

New Records: Fiji-Viti Levu: Laucala Bay, experimental mussel raft, July 1979, QM G12585.

Previous records: Western Australia, Tasmania — Kott, 1962.

Description

In addition to the Fijian colony the following material has been examined. *Trididemnum spiculatum* Kott, 1962: Holotype, AM Y1626; Paratype, AM Y1628; Paratype, AM Y1630.

Colonies: The living colony is white and forms a large thin investing sheet. The anterior end of each zooid slightly projects from the surface, and the thin superficial layer of bladder cells becomes even thinner over each zooid. Zooids are evenly distributed. The cloacal cavity is thoracic. Spicules are absent from the border of the cloacal apertures. They are present in a thin layer below the bladder cell layer and again in the base of the common cloacal cavity but there are no spicules present in the rather thick basal test. Spicules outline the test over the branchial lobes. The spicules are 0.02 to 0.03 mm, with about 12 conical rays in optical section. The distal pointed section of each ray is relatively short and is supported in a pentagonal basal part that is of greater diameter. There is no pigment present in these colonies.

Zooids: These are about 1.25 mm long. There is a distinct branchial sphincter and 6 minute, pointed, branchial lobes. The atrial aperture is an incut opening exposing the mid-dorsal part of the branchial sac. The retractor muscle is about half the length of the abdomen. There are 3 rows of 6 stigmata. The vas deferens coils $6\frac{1}{2}$ times around the single ♂ follicle.

Remarks: The distribution of spicules in this species is reminiscent of other species of *Trididemnum* (including *T. cerebriforme* and *T. savignii*). The species is distinguished by its incut atrial aperture, small spicules, and absence of pigmentation. The specimen from Heron Is. reported to have plant cells (Kott, 1962) was wrongly identified with this species. On examination that specimen (AM Y1627) is found to be a specimen of *Trididemnum paracyclops* Kott, 1980.

The recorded distribution is puzzling and the possibility that more than a single species is involved should not be overlooked.

Lissoclinium bistratum (Sluiter, 1905)

Didemnum bistratum Sluiter, 1905, p. 18.

Lissoclinium bistratum: Kott, 1980, p. 16 and synonymy.

New Records: Ba, open reef flat, LWM, July 1980, QM GH15. The species is common at all locations around Viti Levu throughout the year.

Remarks: The colonies from this station have dense spicules in the surface test and patches of carotenoid pigment that are seen as pink patches over the white spicules. The colonies are found on the open reef flat, in a habitat more commonly exploited by *Lissoclinium voeltzkowi*. Kott (1980) has referred to the reduction in density of plant cells in the surface of *L. voeltzkowi* where the colony is shaded. The dense layer of spicules in the surface of these colonies of *L. bistratum* and more commonly in *L. voeltzkowi* appears to be associated with protection of the plant cells from the direct light of the open reef flat.

Similar populations of *L. bistratum* have been observed on the open reef flat at Lizard Is. in the Great Barrier Reef.

Larvae were present in July 1979 and 1980. They were not present in May or June 1980.

Lissoclinium patellum (Gottschaldt, 1898)

Didemnoides patella Gottschaldt, 1898, p. 653.

Lissoclinium patellum: Kott, 1980, p. 18 and synonymy.

New Record: Suva Barrier Reef, LWM, July 1980, QM G12918.

Remarks: The species has not previously been taken from Fiji. It is not a normal

component of the reef flat fauna and is more often found in deeper water. Only a single small colony is represented by this record.

Lissoclinum punctatum Kott, 1977

Lissoclinum punctatum Kott, 1977, p. 620; Kott, 1980, p. 20.

Records: The species occurs at all locations around Viti Levu and on the Great Astrolabe Reef.

Remarks: It is very inconspicuous, occupying cryptic habitats amongst weed and binding rubble. Records are available for July 1979, and June and July 1980. The mature larva of this species is not known.

Lissoclinum voeltzkowi (Michaelsen, 1920)

Didemnum voeltzkowi Michaelsen, 1921, p. 54.

Lissoclinum voeltzkowi: Kott, 1980, p. 13 and synonymy.

Records: The species is always present and common at most locations around Viti Levu in very extensive populations over the reef flat, often exposed at low tides.

Remarks: Larvae were present in July 1979 and June and July 1980, but were absent in May 1979 when the colonies appeared to be actively lobulating.

On the vast sandy reef flat at Mumbualau there are patches of this species growing on the higher contours that are exposed for slightly longer periods at low tide. It is possible that, when covered by the tide, more light falling on these high points than on other parts of the otherwise level reef flat may attract larvae to settle there, for it seems unlikely that an advantage is associated with their longer exposure at low tide. Colonies from many locations are often found overlapping one another's borders and it is always an upper border that overlaps the colony above it. It is not known whether this is a result of growth or actual movement of the colonies, although, again, this could be a response to light.

Diplosoma listerianum (Milne Edwards, 1842)

Leptoclinum listerianum Milne Edwards, 1841, p. 295. Berrill, 1950, p. 125 and synonymy.

Diplosoma listerianum: Millar, 1955, p. 174. Rowe, 1966, p. 458 and synonymy.

Didemnum gelatinosum Milne Edwards, 1841, p. 295. Berrill, 1950, p. 122 and synonymy.

Diplosoma rayneri MacDonald, 1859, p. 373. Kott, 1976, p. 72.

Leptoclinum rayneri: Kott, 1962, p. 305; 1966, p. 290.

Diplosoma macdonaldi Herdman, 1886, p. 315. Eldredge, 1967, p. 231, and synonymy.

Leptoclinum mitsukurii: Tokioka, 1967, p. 100.

Distribution

New Records: Fiji-Viti Levu: Suva Barrier Reef, LWM, July 1979, QM G12489; Sandbank Reef, July 1980; Votua-lai-lai, July 1980. Great Astrolabe Reef: Dravuni, July 1980, QM GH80.

Previously Recorded: Records of this species and its synonyms are from the tropical western and eastern Atlantic, the eastern (California, Vancouver Is.) mid and western Pacific (including Japan, New Zealand, eastern Australia), South Australia, south-western Australia, South Africa, Mediterranean, English Channel, North Sea (see Eldredge, 1967; Rowe, 1966).

Description

Colony: The species forms characteristically thin sheets, sometimes extending over

considerable areas like a grey slime that breaks up very readily when attempts are made to remove it from the substrate. The test is usually grey and transparent. The colony is identifiable as an ascidian only by the darkly pigmented zooids embedded in it. The common cloacal cavity is extensive, the zooids present in the test strands that extend between the thin basal and surface test. There are minute (0.015 mm in maximum diameter) morulae that resemble small spicules, sparsely distributed in the test strands but not in the surface or basal test. When magnified they are seen to be clusters of translucent spheres (Eldredge, 1967). In the tropics opaque colonies that are tan with streaks of grey and white occur. In preservative the colours are lost. In these colonies the morulae are found in dense clouds in the surface as well as in the test strands.

Zooids: Zooids have the usual dark pigment in the body wall, especially anteriorly and around the abdomen. Beneath this pigment the gut wall is yellow in the preserved specimen. There is a small black pigment spot just posterior to the dorsal ganglion.

Remarks: The type species of the genus *Diplosoma* was described in some detail by MacDonald (*D. rayneri* MacDonald, 1859). Rowe (1966) described a neotype for *D. listerianum* (Milne Edwards, 1841) and confirmed the synonymy of Pacific and Atlantic species with it. Its thin, almost mucus-like test, morulae, pigmented zooid and extensive cloacal cavity are distinctive.

Diplosoma multipapillata Kott, 1980

Diplosoma multipapillata Kott, 1980, p. 29.

New Records: Malevu, under cascades: September 1979, QM G12920; November 1979, QM G12904; December 1979, QM G12900; April 1980, QM G12902; May 1980, QM G12863, behind *Sargassum* zone reef crest, June 1980, QM GH16; under cascades, July, 1980, QM G901; Votualailai, under cascades July 1980, QM G12864; Namanda, under cascades, July 1980, G12869.

The new records indicate that this species is probably confined to the cascades along the riverine reef crests of the southwestern fringing reefs wherever these are bisected by a river channel. Where the river empties onto the reef, close inshore, there is a wide embayment cut in the reef and the moat between the reef and shore drains into this embayment. *D. multipapillata* is not found under the cascades emptying into this inshore bay. It is found on the reef rim, under the cascades, further out from the shore, where the river channel is narrow and receives the drainage from the reef flat rather than the inshore moat. The species also extends for a short distance around onto the surf zone of the seaward face of the reef. However its range along the seaward reef crest is interrupted by the *Sargassum* zone which occurs on the seaward slope of these reefs.

Specimens collected in September at Malevu did not have larvae, but in those collected in June and July the larvae were plentiful.

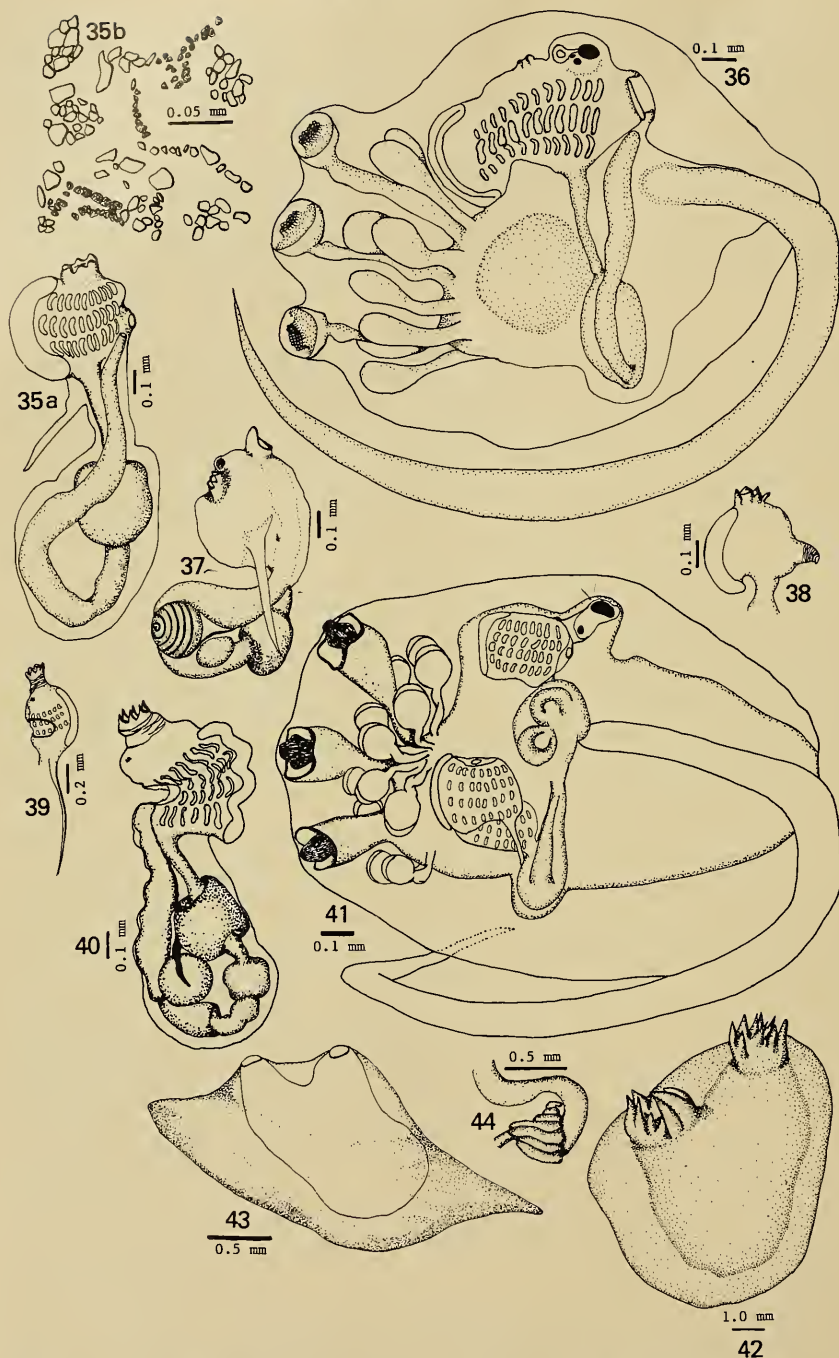
Diplosoma similis (Sluiter, 1909)

Leptoclinum simile Sluiter, 1909, p. 77.

Diplosoma similis: Kott, 1980, p. 26, and synonymy.

Records: The species is especially common near the reef edge at all locations in the surf zone. Here it encrusts the under surfaces of the reef canopy and grows amongst the deep rubble. The sheeting colonies can be seen encroaching through the spaces in the surface of the reef.

Remarks: The species is distinguished from *Diplosoma virens* by its simple cloacal space and a shorter retractor muscle from the posterior end of the thorax. The



Figs 35-44. 35, 36, *Trididemnum discrepans* (QM G12475) : 35-a, zooid; b, pigment cells, 36, larva. 37, *Trididemnum savignii* (QM G 12618), zooid. 38, *Trididemnum cerebriforme* (QM G12574), thorax. 39, *Trididemnum spiculatum* (QM G12585), thorax. 40, 41, *Echinoclinum pacificense* (QM G12584) : 40, zooid. 41, larva. 42, *Ascidia rhabdophora* (QM GH82), external appearance. 43, 44, *Polyzoa depressa* (QM G12610) : 43, single zooid in colony. 44, gut loop.

distinction between the larva and that of *D. virens*, based on the number of ectodermal ampullae (Kott, 1980) has been found to be unreliable. Larvae have been found with 3 pairs of ectodermal ampullae (June 1980, Tagaque, QM G12915, and July 1980, Suva Barrier Reef, QM GH65) and with 4 pairs of ampullae (July 1980 Mumbualau QM G12916). Although Kott (1980) believed that 4 pairs of ampullae were characteristic of *D. midori*, the specimens from Mumbualau are in all other respects identical with *D. similis*.

The colonies from Tagaque with 3 larval ampullae are polygonal, and about 2 cm in diameter, resembling larger colonies of *D. virens* or *D. midori*. These are in other respects identical with *D. similis*. They therefore have affinities with *D. similis* and *D. midori*, and suggest that *D. midori* may be synonymous with *D. similis*.

Diplosoma virens (Hartmeyer, 1909)

Leptoclinum virens Hartmeyer, 1909, p. 1456.

Diplosoma virens: Kott 1980, p. 22, and synonymy.

Records: Massive populations of small colonies were common over much of the reef flat at all locations around Viti Levu in July 1979. In July 1980 small aggregations were found on the south-western fringing reefs, but in general, the species was much less common on the reef flats. It is possible that the reef flat populations (together with those of *T. cyclops*) were affected by the cyclone and cyclonic rains that had occurred in the previous month. One population of large (up to 2 cm), flat colonies was found at about 3 m at Mumbualau, July 1980 (QM G12895).

Remarks: There is considerable variation in the size and appearance of colonies of this species. Those from Mumbualau (QM G12895) encrusting a branch of *Acropora* are larger than the small oval specimens so common on the reef flat. The species is distinguished by the complexity of thoracic cloacal canals and by the long retractor muscle that is free from about halfway down the long oesophagus. Kott (1980) suggested that the number of larval ampullae could be used to distinguish *Diplosoma* species. The varying number of larval ampullae found in Fijian material collected in 1979-1980 clearly indicate that this is not a reliable specific character. There is also variation in the number of adhesive organs.

Larvae were taken in colonies from Malevu and Votualailai in November 1979 and July 1980 (QM G12897, 12866, 12878). They have 2 to 3 pairs of ectodermal ampullae, or sometimes 2 and 3 on respective sides of the adhesive organs. Occasionally there are 4 or 5 adhesive organs in the midline instead of the usual 3. Colonies were also taken in September (QM G12876), December (QM G12875) 1979, and February (QM G12898), March (QM G12879), June (QM G12877) 1980 that generally have mature ♂ and ♀ gonads but that do not contain larvae.

Echinoclinum pacificense n. sp.

Figs 34b; 40, 41

?*Echinoclinum verrilli*: Tokioka, 1958, p. 315.

Distribution

New Records: Fiji-Viti Levu: Suva Barrier Reef, LWM, July 1979, Holotype QM G12584; Makaluva, Paratype, QM G12463. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH59. Great Barrier Reef — Heron Is., LWM, QM G9467.

Previously Recorded: ?Japan (Sagami Bay) — Tokioka, 1958.

Description

Colony: Colonies are small and investing with rounded borders, up to 2 cm in greatest

extent and 2 to 3 mm thick. In life they are faintly yellow and translucent and in preservative the faint yellowish colour is still present. There are small white points in the surface where spicules fill the test where it covers the branchial lobes. The zooids are seen through the test as white flecks owing to a capsule of sparse spicules around each zooid. There is a fairly even layer of spicules in the superficial layer of test, but elsewhere the spicules are very sparse. The characteristic spicules have 3 to 5 pointed rays and there is 0.03 to 0.04 mm between the tips of the rays.

A characteristic of this and other related species (see below, Remarks) is the extremely soft test. The colony is very easily torn during or after collection. Separation of the superficial layer of test also occurs very easily and may be an artefact associated with violent contraction of the zooids into the centre of the colony. The cloacal cavities consist of long canals at thoracic level which open into an extensive posterior abdominal space.

Zooids: The zooids with contracted thorax are about 1.5 mm long. There is a very strong branchial sphincter. The 6 branchial lobes are thin and pointed. The atrial opening is incut, exposing the mid dorsal part of the branchial sac. There are about 6 strong longitudinal thoracic muscles. There are 6 elongate, rectangular stigmata in each row. The gut forms a simple vertical, or slightly curved loop. The stomach, duodenal swelling and mid intestine are distinct. The single ♂ follicle is a rather flattened sphere with the duct extending straight anteriorly from the middle of its outer surface. It is not hooked around the posterior border of the gland.

Larvae: Eggs and embryos at all stages of development are present in the test below the zooids, and in the basal test, especially around the borders of the colony around the posterior abdominal cavity. The trunk is large, 1.2 mm long, and the tail is relatively short, extending only about one third of the distance around the trunk. The larva has an ocellus and an otolith, and there are two blastozooids that develop from the oesophageal region of the oozoid. The 3 median adhesive organs have stout stalks and deep ectodermal cups around the deep solid adhesive cones. There are 6 pairs of lateral ampullae. As these mature their stalk narrows. The terminal portion remains swollen and spherical (balloon-like) with very flat epithelial cells and a small hyaline cap on its outer surface. There are small particulate inclusions in the larval test, but these are very much smaller than the inclusions (spicules?) that in *E. verrilli*; Kott, 1972a, obscure the structure of the larva.

Remarks: The spicules of this species are of similar form to those described for other species of this genus, formerly all referred to as synonyms of *E. verrilli* Van Name, 1902. Specimens of *E. verrilli* from the Western Atlantic (Van Name, 1902: Gulf of Mexico AMNH 471, 494; Florida AMNH 484) have been examined. The Atlantic species differs from the present species in its firm gelatinous test, with zooids in double rows along either side of deep canals in deep narrow furrows around circular zooid-free areas of test that form rounded swellings on the surface. The zooids are smaller than those of the present species (1 mm long), and the spicules are larger (0.07 mm between tips of rays). Although Van Name (1945, p. 116) indicates that there were 'probably nearly a dozen (stigmata) in a row on each side', only 4 or 5 stigmata were present in the specimens examined. The larva has only 4 pairs of ectodermal ampullae and a long tail wound one and a half times around the small larval trunk (0.6 mm long).

Echinoclinum verrilli: Kott, 1972a, from South Australia is distinct from both the Atlantic species and *E. pacificense*, having 14 pairs of larval ampullae. Its colony, zooid and larval size resemble those of the present species. The affinities of specimens from West Africa (Millar, 1953) and the Tasmanian coast (Kott, 1962) remain in doubt.

The generic status of the group of species is also in doubt. Eldredge (1967) has suggested that the genus *Echinoclinum* is not distinct from *Lissoclinum*. The larvae with their blastozooids and numerous modified lateral ampullae do resemble those of species of *Lissoclinum*, and certainly the presence of tetrahedral spicules does not preclude an affinity with any didemnid genus, including *Lissoclinum*. However the separation of the genera *Echinoclinum* and *Lissoclinum* is based on differences in the origin and course of the vas deferens. In the latter it is hooked around the posterior border of the male gland from its ventral surface, while in the present genus it originates from the middle of the dorsal surface and extends straight forwards. Van Name (1945) has described testes follicles in which the vas deferens extends in a groove around the follicle from its ventral surface. This requires confirmation.

Echinoclinum triangulum Sluiter (see Kott, 1980) resembles the present species in its very soft colonies, sheaths of rather unusual spicules around each zooid, and straight vas deferens. It differs from other species of *Echinoclinum* (and of *Lissoclinum*) in the absence of larval blastozooids (Millar, 1975). It is also separated from other species of *Echinoclinum* by the form of the spicules and the presence of symbiotic plant cells in the test (Kott, 1980). The form of the larval ampullae is not clear from Millar's description and those with spherical tips and squamous epithelial cells may be characteristic of the 'verrilli' group of species rather than a generic characteristic.

Order PHLEBOBRANCHIA

Family PEROPHORIDAE

Perophora formosana (Oka, 1931)

Ecteinascidia formosana Oka, 1931b, p. 173.

Perophora formosana: Tokioka, 1953a, p. 218.

Perophora bermudiensis Berrill, 1931, p. 78. Van Name, 1945, p. 167 and synonymy.

Péres, 1949, p. 190. Tokioka, 1950, p. 125. Kott, 1952, p. 315; 1964, p. 147.

Vasseur, 1966, p. 149

Perophora orientalis Ärnback-Christie-Linde, 1935, p. 6.

Distribution

New Records: Fiji-Levu: Makaluva, LWM, July 1979, QM G12468; Sandbank Reef, LWM, July 1980, QM G12938.

Previously Recorded: Tropical western and eastern Atlantic — see Van Name, 1945; Péres, 1949. Malagasy — Vasseur, 1966. Palau Is. — Tokioka, 1950. New South Wales — Kott, 1952. Queensland (Moreton Bay) — Kott, 1964. Japan — Oka, 1931; Ärnback-Christie-Linde, 1935; Tokioka, 1953a.

Description

Colony: Living specimens are seen as small yellow bubbles, up to 3 mm in diameter on the under surface of rocks at low tide. In preservative the zooids are transparent. Short stalks from the postero-ventral aspect of the body attach it to anastomosing basal stolons.

Zooids: The conspicuous body musculature extends from across the dorsal surface behind the atrial siphon and transversely and obliquely across the body to the ventral border. There are 5 rows of 15 stigmata, and 12 internal longitudinal branchial vessels. The single compact ♂ gland in the loop of the gut is diagnostic.

Remarks: The relatively limited number of records of this small inconspicuous species is probably the result of a cryptic habitat, under rocks, and the fact that it is difficult to remove undamaged from the substrate. Its distribution will very likely be found to be pantropical.

Ecteinascidia nexa Sluiter, 1904

Ecteinascidia nexa Sluiter, 1904, p. 11.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, on the under side of rubble, LWM, July 1980, QM G12938. Great Barrier Reef: Heron Is. — unpublished records.

Previously Recorded: Indonesia — Sluiter, 1904. North-east Queensland (Hervey Bay) — Kott, 1966.

Description

External appearance: The species forms a mat of small (about 0.5 cm) almost spherical yellowish bubbles. The zooids are fixed along almost their whole ventral or ventro-lateral surface to basal stolons which form a network on the substrate. They are also joined to adjacent zooids by narrow test connectives. Both apertures are sessile, and directed upwards. The atrial aperture is half-way along the dorsal surface.

Internal structure: There are 17 rows of about 20 stigmata with 15 internal longitudinal vessels on each side. Short longitudinal muscles radiate only a limited distance from the apertures and represent the only conspicuous musculature. The dorsal lamina is represented by antero-posteriorly flattened pointed languets without any connecting membrane between them. The smooth stomach is almost spherical. The intestine forms a wide loop and the rectum extends forwards for only a short distance to the atrial aperture. The testis follicles are very small and form an arc distal to a small group of ova.

Remarks: Although seldom recorded, this is a common species under rocks along the north-eastern coast of Australia and probably throughout the Indo-west Pacific. It is probable that it rarely appears undamaged in collections as its prostrate growth makes it very difficult to scrape off the substrate. The connectives joining the test of adjacent zooids comprise the only distinction from *E. tortugensis* Plough and Jones (see Van Name, 1945). These test connectives, the smooth stomach and the flattened languets of the dorsal lamina are diagnostic.

Family RHODOSOMATIDAE

Subfamily CORELLINAE

Corella japonica Herdman, 1882

Corella japonica Herdman, 1882, p. 190. Tokioka, 1953a, p. 231 and synonymy; 1967, p. 148. Vasseur, 1967b, p. 132. Tokioka and Nishikawa, 1975, p. 332. Millar, 1975, p. 266. Nishikawa and Tokioka, 1976, p. 392.

Distribution

New Records: Fiji — Viti Levu: July 1979, Suva Barrier Reef, LWM, QM G12007.

Previously Recorded: Japan — Herdman, 1882; Hartmeyer, 1906; Tokioka, 1953a, 1967; Tokioka and Nishikawa, 1975; Millar, 1975; Nishikawa and Tokioka, 1976. Hong Kong — Herdman, 1882. Noumea — Vasseur, 1967b.

Description

Inconspicuous glassy individual from 5 to 10 mm long, fixed by a large part of the right side to under surfaces.

Remarks: These specimens appear to be juveniles. The species is most often recorded from Japan but it very likely has a wider range than its present records suggest. It is distinguished from the tropical eastern Atlantic *C. minuta* and the temperate Antarctic *C. eumyota* by its conspicuous muscle bands crossing the dorsal line in the intersiphonal region.

Family ASCIDIIDAE
Ascidia rhabdophora Sluiter, 1904
 Fig. 42

Ascidia rhabdophora Sluiter, 1904, p. 45. Tokioka, 1953a, 220.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, LWM, July 1979, QM GH117; Makaluva, LWM, July 1979, QM GH146. Great Astrolabe Reef: Dravuni, LWM, July 1979, QM GH82. Great Barrier Reef — unpublished records.

Previously recorded: Indonesia — Sluiter, 1904. Japan — Tokioka, 1953a.

Description

External appearance: The individuals are small (1 cm long), almost circular, laterally flattened and fixed to the substrate by almost the whole of the left side. The branchial aperture is terminal and the atrial aperture one third to half the distance along the dorsal border. Forward projecting, pointed, hollow test papillae (up to 2 mm long) crowd around the sessile apertures and corresponding projections of the body wall are accommodated in the hollow of each papilla. As the individual grows these papillae become less conspicuous and relatively shorter. The remainder of the test may be translucent or glassy and sometimes it is smooth but it may be rough and uneven, with rounded swellings on the surface or minute pointed papillae may be present all over the right side.

Internal structure: There are short radiating muscles from both apertures. These extend half way across the right side of the animal but on the left they extend only a very short distance from the apertures. In preserved material there is some yellowish pigment in the branchial tentacles. A comma-shaped opening of the neural gland is present in the prebranchial area and there is not the usual peritubercular area projecting posteriorly along the mid line. The dorsal lamina is a wide membrane with strong ribs on the left. It is continuous anteriorly to a line level with the prebranchial groove. Here, in its anterior extent, it is separated into two lamellae by a deep median groove. The branchial sac has the usual papillae projecting inwards from the internal longitudinal vessels at their junction with transverse and parastigmatic vessels. There are also distinct but sometimes minute intermediate papillae between the primary papillae in most parts of the branchial sac.

The gut forms a fairly narrow deeply-curved loop, the rectum extending forwards almost parallel with the ascending limb of the primary loop. The stomach, across the posterior end of the left side of the body, is short and almost spherical. Internally it is divided into 4 longitudinal glandular areas. The proximal part of the ovary, in the pole of the gut loop is very much branched. The distal part curves around inside the gut loop and extends anteriorly parallel to the rectum to open alongside the smooth anal opening.

Remarks: The species is distinguished by the absence of the peritubercular area, the presence of intermediate papillae, the comma-shaped opening of the neural duct. It closely resembles *A. bisulca*: Millar, 1975, but is distinguished by its dorsal tubercle. Like the Japanese specimen (Tokioka, 1953a) the Fijian specimens lack the calcareous spicules that Sluiter (1904) had observed in the inner layer of test. Tokioka (1953a) believes these to be foreign bodies.

Ascidia melanostoma Sluiter, 1885

Ascidia melanostoma Sluiter 1885, p. 172; 1904, p. 30.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, July 1979, QM G12700; July

1980, QM GH119.

Previously Recorded: Indonesia — Sluiter, 1885, 1904.

Description

External appearance: Glassy, translucent with black pigment in the test, branchial sac, and especially in the anterior part of the body and in distinct stripes in the siphonal linings. There are 9 stripes in the branchial siphon. There are conspicuous pigment spots (possibly light sensitive) at the apex of the lobes around the apertures. The branchial aperture is terminal. The atrial aperture, from one half to two thirds of the way along the dorsal surface is on a short siphon that is sometimes turned posteriorly. Specimens are from 2 to 4 cm long, about 2 cm wide.

Internal structure: There is a fairly open irregular mesh-work of muscles on the right side of the body. These are reorganized into short parallel bands extending across the ventral border. On the left side of the body the musculature is confined to longitudinal bands radiating down as far as the gut loop. The branchial tentacles are crowded, and the very narrow prepharyngeal area is papillated. There is a shallow peritubercular area and the dorsal tubercle has a simple circular or U-shaped opening. The dorsal ganglion is a short distance behind the dorsal tubercle, about half way between the tubercle and the base of the atrial siphon. Anteriorly, for one sixth of its length or less, the lamina is a double membrane. It is strongly ribbed on both sides along its whole length, each rib extending from the border of the membrane to form a regular fringe of distinct tongue-like projections. The branchial sac has about 6 stigmata in each mesh. The branchial papillae are round with a slight swelling on the dorsal side. There are no intermediate papillae. The gut forms a narrow double loop. The secondary loop is very deep. The anal border is bilabiate. The specimens have mature ♂ and ♀ gonads, the vas deferens and oviduct being filled with genital products. Long branches of the ovary obscure the ♂ follicles, and extend over most of the mesial surface of the gut loop and gonoducts. They also extend through the pole of the gut loop and spread over its lateral side.

Remarks: The shape of the body, the branchial sac, the body musculature and the shallow prepharyngeal region are similar to those of *Ascidia gemmata*. Kott (1972a) has ascribed specimens with the dorsal lamina a single membrane for the whole of its length to *A. gemmata*. However, Tokioka (1950) shows a double membrane anteriorly for specimens that are the scarlet colour that he regards as characteristic of that species (Tokioka, 1950, 1952). The colour of the living specimens, therefore, appears to be the only reliable character that can be used to distinguish *A. gemmata* from the present species. Further studies on variation in pigmentation of living material are essential to establish the relationships of these species.

Suborder STOLIDOBANCHIA

Family STYELIDAE

Subfamily POLYZOINAE

Polyzoa depressa (Oka 1926)

Figs 43, 44

Dictyostyela depressa Oka, 1926, p. 348.

Polyzoa sagamiana Tokioka, 1953a, p. 245. Kott, 1964, p. 131.

Distribution

New Records: Fiji — Viti Levu: Suva Barrier Reef, LWM, July 1979, QM G12610; Laucala Bay, 10 m July 1979, QM G12613.

Previously Recorded: Japan — Oka, 1926; Tokioka, 1953a. Great Barrier Reef (Heron Is.) — Kott, 1964.

Description

External appearance: The species consists of small hemispherical or oval individuals firmly fixed to the substrate by the ventro-lateral (right) surface. The maximum size of the zooids is 3 mm. The test is transparent and fairly thin, but tough, and the bright red body wall shows through. The test spreads out over the surface beyond the zooid. Stolons join adjacent zooids but the test also spreads out from these, as well as around the zooid to form an almost continuous basement membrane. The branchial aperture is toward one end of the upper surface and the atrial aperture is in the centre of the upper surface (dorso-lateral left side of the body). The apertures are sessile and have smooth rims when extended.

Internal structure: There is diffuse musculature in the body wall. A few short longitudinal bands radiate from each siphon. There are 8 internal longitudinal vessels on each side of the branchial sac and 8 rows of about 30 stigmata, each crossed by a parastigmatic vessel. The stomach is pyriform, narrow at the cardiac end, with 12 oblique folds. There is a short curved caecum in the loop of the gut, which lies along the longitudinal axis of the zooid to the left of the endostyle at the outer margin. The rectum extends dorsally and anteriorly toward the atrial aperture. There are 3 gonads in the body wall, just to the left of the endostyle, each consisting of a single ♂ follicle underneath the ovary with a short oviduct directed antero-dorsally. There are up to 5 larvae in the antero-ventral part of the peribranchial cavity to the left of the endostyle.

Larvae: These have an almost spherical trunk, and a short stout tail that is only slightly longer than the trunk. There is a single pigmented sense organ and three anterior adhesive organs arranged in a close triangle. There are no ectodermal ampullae.

Remarks: Specimens from Sagami Bay and Heron Is. (QM G4951) have up to 11 rows of stigmata. The latter have gonads with 2 ♂ follicles on both sides of the endostyle. The number of gonads and rows of stigmata in Oka's specimens is not known. Specimens from Heron Is. (Kott, 1964) have 6 gonads on the right side of the endostyle and 4 on the left toward the middle of the body but these are not mature and the number of ♂ follicles was not determined. These specimens have 8 rows of stigmata. The number of internal longitudinal vessels, the presence of parastigmatic vessels, the size and form of the zooids, and the structure of the gut are the same in all specimens. The number of ♂ follicles and the gonad position and numbers appear to vary with the orientation of the body and the stage of sexual maturity it has reached and do not appear to constitute a specific distinction. In due course it is likely that this inconspicuous species will be found to have a wide range in the Indo-west Pacific.

The species has a superficial resemblance to *Polyandrocarpa imthurni* (Herdman) and the closely related *P. latericius* (Sluiter), both of which have a similar geographic range to that of the present species. They are distinguished however by the presence of the 4 branchial folds that are characteristic of *Polyandrocarpa*.

Symplegma oceania Tokioka, 1961

Symplegma oceania Tokioka, 1961, p. 114.

Symplegma viride: Michaelsen, 1904, p. 50; 1918, p. 39; 1919, p. 101. Michaelsen and Hartmeyer, 1928, p. 358. Kott, 1952, p. 253; 1964, p. 129; 1975, p. 11; 1976, p. 74. Millar, 1966, p. 368. Plante and Vasseur, 1966, p. 149; Vasseur, 1967a, p. 111. Tokioka, 1967, p. 162. Kawamura and Nakauchi, 1976, p. 4.

Symplegma aff. *viride*: Tokioka and Nishikawa, 1975, p. 334.

Diandrocarpa brakenhielmi Michaelsen, 1904, p. 50. Herdman, 1906, p. 331.

Not *Symplegma viride*: Van Name, 1945, p. 232 (part, Atlantic records).

Distribution

New Records: Fiji — Viti Levu: July 1979, Laucala Bay, experimental mussel raft; Makaluva, July 1980, LWM, QM GH 147.

Previously Recorded: Circum-Australia — Kott, 1952, 1964, 1972c, 1976; Millar, 1966. Noumea — Tokioka, 1961. Palau Is., Thailand, China — Tokioka, 1967; Tokioka and Nishikawa, 1975. Sri Lanka — Herdman, 1906. Indian Ocean — Michaelsen, 1904, 1918, 1919; Michaelsen and Hartmeyer, 1928; Vasseur, 1967a; Plante and Vasseur, 1966.

Description

External appearance: Colonies form the usual large investing sheets that overgrow other sessile organisms and, in the present location, compete for space with *Didemnum psammatoedes*. Habitats are often muddy, with fine sediments. The Fijian populations are a mixture of orange-red and pale creamish-lemon colonies.

Remarks: The species is common around the Australian coast. Specimens from a range of locations on the central Queensland coast (QM G4939, 4938, 4942, 4941) have 8 to 14 rows of stigmata and 10 to 16 stomach folds. The arrangement of the gastro-intestinal duct and vessels is extremely variable and includes the arrangements described by Tokioka for *S. oceania* and for *S. viride*. The single or branched duct extends from a variable level between the middle and base of the outer convex side of the gastric caecum (which may be curved or almost straight) to the descending limb of the primary gut loop. Single or branched vessels also extend from the tip of the caecum to the ascending limb of the primary gut loop (distal to the stomach) where they ramify over the intestinal wall. These vessels and ducts associated with the caecum are very delicate, embedded in the membranes of the body wall that cover the gut loop.

The species is distinguished from the Atlantic species *S. viride* Herdman principally by the fact that the zooids of *S. viride* have protostigmata, which are suppressed in the Pacific species; and the mode of test vessel formation is different in the Atlantic species (Kawamura and Nakauchi, 1976). Other Pacific species, *Symplegma reptans* Oka (see Tokioka, 1951), *S. connectens* Tokioka (1949b, 1953) and *S. japonica* Tokioka (1962), can be distinguished from *S. oceania* by the absence of ampullae in the larvae of the two former species, the absence of a gastric caecum in *S. connectens* and the large number of stomach folds (17 to 20) in *S. japonica*.

Subfamily BOTRYLLINAE

Botrylloides tyreum Herdman, 1886

Botrylloides purpureum: Herdman, 1886, p. 41.

Botrylloides tyreum Herdman, 1886, p. 344, 381, nom. nov. Gottschaldt, 1898, p. 642. Sluiter, 1904, p. 101. Van Name, 1918 p. 111. Tokioka, 1967, p. 111. Millar, 1975, p. 280. Kott and Goodbody, 1981.

?*Botrylloides violaceus marginatus:* Tokioka, 1967, p. 160.

?*Botrylloides violaceus:* Tokioka, 1967, p. 158 and synonym.

?*Botrylloides nigrum:* Kott, 1952, p. 257; 1972c, p. 238; 1976, p. 74.

Distribution

New Records: Fiji — Viti Levu: Sand Bank Reef, LWM, July 1980, QM GH111. Great Astrolabe Reef: Dravuni, LWM, July 1980, QM GH107, 109.

Previously Recorded: Philippines — Herdman, 1886; Van Name, 1918. Palau Is. — Tokioka, 1967. Indonesia — Sluiter, 1904. Eastern and western Australia — Kott, 1952, 1972c, 1973. Japan — Tokioka, 1949a, 1951, 1953b, 1967.

Description

Colony: The Fijian colonies are all thin and investing and sometimes extensive. The zooids are always in double rows sometimes widely spaced and sometimes crowded, with conspicuous elongate terminal ampullae of blood vessels between the rows, and around the periphery of the colony. These preserved specimens are always dark purplish-brown. The pigment is in small cells in the zooids and in the terminal ampullae. The test between the zooid systems is translucent and raised above the level of the zooids in the preserved material. There are dramatic differences in the colour of the living colonies which are orange and buff, buff and yellow, black and white, 'orpiment orange' and black and white, or 'heliotrope' and 'purple'. The white, orange or yellow pigment outlines the atrial languet and the regular and repeated fine pattern varies according to the orientation and contraction of the atrial languet.

Zooids: The relaxed zooids are about 2 mm long. They are upright in the test. The branchial aperture is sessile and smooth-rimmed. The atrial aperture is wide, often exposing most of the branchial sac. Its upper rim is sometimes produced into a lip. There are 12 rows of stigmata with about 14 in each row. The gut loop lies across the posterior end of the left side of the branchial sac. The stomach is pear-shaped and wider at the pyloric end where the 9 longitudinal folds become more pronounced and where there is a small caecum. The caecum varies in length to some extent and is rounded terminally but it is never curved. There is a vascular connective between the caecum and the intestine. The stomach is an orange colour in the preserved specimens. There is a narrow duodenal area between the stomach and a voluminous mid-intestine with thin walls which is present in the pole of the gut loop. There is a slight constriction between the mid-intestine and the intestine. A rosette of 6 or 7 branched ♂ follicles is present on each side of the body in some colonies. The left testis is outside the gut loop and the right testis is in a corresponding position on the opposite side of the body. Small vegetatively produced juveniles in the test posterior to the zooids have a small rounded atrial aperture.

Remarks: The specimens are identical with those previously described from the Philippines (Herdman, 1886; Van Name, 1945; and Millar, 1975). The specimens from the Palau Is. assigned to *B. violaceus marginatus* by Tokioka (1967) also appear to be conspecific with the present specimens and those from the Philippines. *Botrylloides tyreum*: Tokioka, 1967, from the Palau Is., however, has larger zooids, more stigmata in each row, more stomach folds and different proportions of the gut, and is a doubtful synonym. *Botrylloides violaceus* Oka may also be conspecific since although the number of stomach folds and rows of stigmata exceed those of the present specimens (Tokioka, 1967), other specimens from Japan assigned to this species are identical in these characters (see Tokioka, 1949a, 1951, 1953b), although the characteristic pear-shape of the stomach is not always reported for this Japanese species. *Botrylloides nigrum*: Kott, 1952-76, from Australia has the same pear-shaped stomach but often has larger zooids and more rows of stigmata and stomach folds. Its relationship to the present species and to *B. violaceus* requires investigation.

Tokioka (1967) has suggested synonymy of *B. leachii* (Savigny) with *B. violaceus*. However although the zooids are similar the colonies of the two species are quite distinct.

Subfamily STYELINAE

Cnemidocarpa areolata (Heller, 1878)

Styela areolata Heller, 1878, p. 26; Herdman, 1906, p. 316; Van Name, 1918, p. 87.

Tokioka, 1950, p. 145. Kott, 1964, p. 138; 1966, p. 297. Vasseur, 1967b, p. 139.

Cnemidocarpa areolata: Tokioka, 1953a, p. 254; 1953b, p. 14; 1954a, p. 261;

1954b, p. 85; 1959, p. 229; 1961, p. 126; 1962, p. 17; 1967, p. 181.

Cnemidocarpa valborgi Hartmeyer, 1919, p. 35.

Cnemidocarpa irma Michaelsen and Hartmeyer, 1928, p. 388. Hastings, 1931, p. 72. Kott, 1952, p. 217. Millar, 1963, p. 728.

Distribution

New Records: Fiji — Viti Levu: Tai Levu, LWM, July 1979, QM G12683; Suva Barrier Reef, LWM, July 1979, QM G12005; Makaluva, LWM, July 1979, QM G12582. Great Astrolabe Reef: Dravuni, July 1980, QM GH149.

Previously Recorded: Western Australia — Hartmeyer, 1919; Michaelsen and Hartmeyer, 1928; Kott, 1952; Millar, 1963. Queensland — Hastings, 1931; Kott, 1964. Northern Australia — Kott, 1966. Sri Lanka — Heller, 1878; Herdman, 1906. Noumea, Palau Is. — Tokioka, 1950, 1961; Vasseur, 1967b. Philippines — Van Name, 1918. Mariana Is. — Tokioka, 1967. Japan — Tokioka, 1953a, 1953b, 1954a, 1954b, 1959, 1962.

Description

External appearance: Individuals are egg-shaped. They are leathery, orange-chrome in life with dark stripes in the siphons. In preservative they are brown-orange with very irregular surface test, up to 3 cm long, about 1½ cm high and 2 cm broad, dorso-ventrally flattened. They are fixed by the ventral surface and the test here is sometimes irregularly produced. The sessile branchial aperture is terminal, and the atrial aperture, about one third of the body length along the dorsal surface, is also sessile. When the individual is contracted and the surface of the test thrown up into irregular swellings and furrows the closed apertures are especially inconspicuous.

Internal structure: The simple branchial tentacles are fairly long, with a wide posterior flange on each. There is a narrow prepharyngeal area that expands dorsally into a fairly shallow peritubercular area with the dorsal tubercle filling its posterior angle. The opening of the neural duct is a U-shaped slit with the right horn turned in. The branchial folds are fairly high and overlap one another slightly in the contracted specimen. There are about 18 vessels on the folds and 6 between. The oesophagus is fairly short. The stomach is short and pear shaped with internal longitudinal glandular folds. There is a fairly long gut loop of moderate width extending around the postero-ventral curve of the left side of the body and the rectum extends forwards at a wide obtuse angle to the gut loop to form the secondary loop. The anus is bordered with small rounded lobes. A double row of about 8 tall endocarps, sometimes branched, is enclosed in the primary gut loop. Other endocarps are on the body wall between the gonads. Gonads are present in specimens from Dravuni (July 1980). There are two gonads on the left, the posterior one curving anterior to the pole of the primary gut loop. On the right there are three gonads around the ventral half of the body and converging toward the atrial aperture.

Remarks: The specimens collected in 1979 are juveniles and resemble *Polycarpa longiformis* which has similar endocarps on the body wall and in the loop of the gut. The dark stripes in the siphons, the thick body wall that is not closely adherent to the test and the absence of long finger-like anal lobes distinguish the present species.

Polycarpa pedunculata Heller, 1878

Polycarpa pedunculata Heller, 1878, p. 106; Kott, 1972a, p. 35 and synonymy.

Distribution

New Records: Fiji — Viti Levu: Toberua, 2-4 m, July 1980, QM GH78. Great Astrolabe Reef: Dravuni, 1-2 m, July 1980, QM GH85; Yakuve, 1-2 m, July 1980, QM GH79.

Previously Recorded: The species has been recorded from eastern, western and

southern Australia, and from New Caledonia (see Kott, 1972a). There are unpublished records from the north-eastern coast of Australia, Lizard Is., and off Townsville. It is a common benthic species.

Description

External appearance: Specimens collected from Fiji are always large, up to 12 cm long and 5 cm deep (dorso-ventrally). They are laterally flattened when collapsed in preservative but the living specimens are more cylindrical. In life they are brown externally, and the internal siphonal lining is light grey to blue. The siphonal lining is conspicuous, and otherwise the brown external test camouflages the animal. The branchial aperture is wide and terminal, but is turned ventrally and posteriorly. The atrial aperture is on a short siphon one third of the distance down the dorsal surface. The body is fixed to the substrate posteriorly and is usually sessile. The test here is very thick, however, and is sometimes produced into a thick stalk.

Internal structure: The body wall is very muscular with an almost continuous layer of outer circular fibres and an internal layer of less developed longitudinal muscles. Spherical vesicles that are black when the animal is preserved interrupt the muscle bands, and also occur in the pharynx and in the ectodermal lining of the outer wall of the peribranchial cavity. The body wall is closely adherent to the test. The dorsal tubercle is large and triangular completely filling the peritubercular space. The opening of the neural gland is interrupted and convoluted. The branchial sac has thick longitudinal vessels that are especially close together on the low folds.

The gut loop is relatively small, and oriented across the posterior part of the left side of the body at right angles to its long axis. The long stomach, with parallel internal glandular folds, occupies most of the proximal limb of the gut loop. The gut loop encloses the usual circular endocarp. The rectum turns anteriorly to the atrial opening. The anus is fringed by about 20 lobes. The gonads are numerous and deeply embedded in the body wall.

Remarks: The deeply embedded gonads, complicated dorsal tubercle, and large size of these specimens, indicate that they are of some age. It is likely that some of the variations described (Kott, 1972a) for this species represent more juvenile individuals.

Family PYURIDAE

Pyura sacciformis (von Drasche, 1884)

Fig. 34

Cynthia sacciformis von Drasche, 1884, p. 376.

Pyura sacciformis: Tokioka, 1967, p. 197.

Cynthia sanderi Traustedt and Weltner, 1894, p. 11.

Halocynthia sanderi: Hartmeyer, 1906, p. 5.

Pyura sanderi: Tokioka, 1953a, p. 275. Rho, 1966a, p. 6; 1966b, p. 7; 1968, p. 11; 1971, p. 20; 1975, p. 24.

Pyura aspersa Tokioka, 1949a, p. 10.

Pyura masuii Tokioka, 1949b, p. 57.

?*Pyura michaelsoni* Oka, 1906, p. 46. Tokioka, 1954, p. 90 and synonymy. Kott, 1964, p. 140.

Distribution

New Records: Fiji — Viti Levu: Makaluva, LWM, July 1979, QM G12579.

Previously Recorded: With the exception of a single doubtful record from the Great Barrier Reef (Heron Is.) all previous records are from Japan and Korea.

Description

External appearance: The single specimen is 4 cm long, and very irregular. The test is

TABLE I
Distribution of Non-Plant Bearing Ascidiens Occurring at Fiji

Species	Tropical																	Temperate						
	W. Atlantic	E. Atlantic	W. Indian O.	Red Sea	Gulf of Suez	Sri Lanka	NW. Aust.	G.B.R. & N.E. Aust.	Indonesia	Philippines	Tokara Is.	Palau Is.	Noumea	Gilbert Is.	Fiji	Mid Pacific	Hawaii	Japan	N.Z.	Aust.	Africa	Mediterranean	English Channel	E. Pacific
<i>D. listerianum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>C. dellachiajei</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>H. momus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>T. savignii</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>P. formosana</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>T. discrepans</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>D. psammalodes</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>S. oceanica</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>P. recurvatum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>T. cerebriforme</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>D. moseleyi</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>C. areolata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>L. reticulatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>D. granulatum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>E. digitata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>T. spiculatum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>E. arenacea</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>E. digitata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>P. pedunculata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>B. tyreum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>M. exasperatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>S. kuranui</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>D. proliferum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Species	Location	Tropical																	Temperate						
		W. Atlantic	E. Atlantic	W. Indian O.	Red Sea	Gulf of Suez	Sri Lanka	NW. Aust.	G.B.R. & N.E. Aust.	Indonesia	Philippines	Tokara Is.	Palau Is.	Noumea	Gilbert Is.	Fiji	Mid Pacific	Hawaii	Japan	N.Z.	Aust.	Africa	Mediterranean	English Channel	E. Pacific
<i>D. cuculliferum</i>																									
<i>L. rufus</i>								X	X	X	X		X			X									
<i>E. pacificense</i>								X	X	X	X					X									
<i>P. sacciformis</i>								X	X	X	X					X									
<i>P. depressa</i>								X	X	X	X					X									
<i>A. depressum</i>								X	X	X	X					X									
<i>D. chartaceum</i>								X	X	X	X					X									
<i>R. proliferus</i>								X	X	X	X					X									
<i>E. nexa</i>								X	X	X	X					X									
<i>A. rhadophora</i>								X	X	X	X					X									
<i>L. madara</i>								X	X	X	X					X									
<i>P. sundaicum</i>								X	X	X	X					X									
<i>D. digestum</i>								X	X	X	X					X									
<i>D. recurvatum</i>								X	X	X	X					X									
<i>A. melanostoma</i>								X	X	X	X					X									
<i>P. doboense</i>								X	X	X	X					X									
<i>D. albopunctatum</i>								X	X	X	X					X									
<i>L. ocellatus</i>								X	X	X	X					X									
<i>D. valii</i>								X	X	X	X					X									
<i>E. rubra</i>								X	X	X	X					X									
<i>D. sphaericum</i>								X	X	X	X					X									
<i>E. rigida</i>								X	X	X	X					X									
<i>C. japonica</i>								X	X	X	X					X									
<i>P. aurea</i>								X	X	X	X					X									

thin but leathery. There are two concentric circles of lobes that surround the apertures, the inner circle fringing the rim of the openings. There are spines on the outer surface of the inner lobes, and on the rough nodose lobes of the outer circle. The minute pointed spines on the aperture lobes are only 0.05 to 0.07 mm long.

The test is red or carmine deep between the lobes and in the inner lining of the siphons. The apertures are both on short siphons and are fairly close together.

Internal structure: The dorsal tubercle is at the base of the tentacles, to the right of and well removed from the anterior end of the dorsal lamina. The opening is fairly complicated and branched, the terminal end of each branch slightly coiled. The branchial tentacles are almost simple pinnate, secondary branches being small and tertiary branches minute. There are 7 overlapping branchial folds on the left and 6 on the right. The gut loop is narrow and curved, and there is a single gonad in the gut loop and in a corresponding position on the opposite side of the body. The gonads are broken up into a varied number of lobes along each side of the central duct.

Remarks: The horny curved spicules in the body (see Tokioka, 1967) were not observed in this specimen. The irregularity of the body helps to conceal it, despite the red colour in the anterior part of the test. Further collecting should demonstrate continuity between the widely separated locations from which the species has been reported.

Microcosmus exasperatus Heller, 1878

Fig. 34d

Microcosmus exasperatus Heller, 1878, p. 99, Tokioka, 1952, p. 130. Van Name, 1945, p. 346 (? and synonyms from Atlantic locations). Vasseur, 1967b, p. 142.

Microcosmus exasperatus typicus: Michaelsen, 1908, p., 272.

Microcosmus variegatus Heller, 1878, p. 100.

Microcosmus miniatus: Van Name, 1902, p. 396 and synonymy.

Microcosmus claudicans australis: Michaelsen and Hartmeyer, 1928, p. 402. Kott, 1952, p. 288.

Microcosmus australis: Millar, 1963, p. 741. Kott, 1966, p. 373; 1972d, p. 53; 1976, p. 85.

Distribution

New Records: Fiji — Viti Levu: LWM, Suva Barrier Reef, July 1979, QM G12701.

Previously Recorded: West-Indies — Heller, 1878; Traustedt, 1882; Michaelsen, 1908; Van Name, 1902. East Africa — Michaelsen, 1908. New Caledonia — Vasseur, 1967b. Formosa — Michaelsen, 1908. Northern Australia — Kott, 1952, 1966, 1972d; Tokioka, 1952. Western Port Bay (Victoria) — Kott, 1976.

Description

In addition to the newly recorded material, the following specimens from the West Indies have been examined: *M. exasperatus*, Kingston, Jamaica, QM GH154.

External appearance: The single specimen is juvenile, 5 mm in diameter, with a short conical terminal branchial siphon and subterminal atrial siphon. The body is almost spherical, brownish-purple, and smooth. The test is fairly thin but tough, with a pearly glistening internal lining.

Internal structure: The lining of the siphons has red stripes. Just inside the opening there are minute scales with median points, about 0.03 mm long. The branchial tentacles are branched, but not bushy. The dorsal tubercle has a simple U-shaped opening with the horns turned in. There are 7 branchial folds on the left and 6 on the right. The folds vary in width, and the widest has about 109 longitudinal vessels of variable thickness. The gut forms a long narrow loop around the ventral part of the left side. Gonads are not developed.

TABLE 2
Distribution of Plant-Bearing Didemnid Ascidians Occurring off Fiji

Species	Zanzibar 5°S	Malagasy 20°S	Red Sea 20°N	Sri Lanka 8°N	Indonesia 10°S	Darwin 10°S	N. Australia 32°S	Cockburn Sd 32°S	W. Australia 24°S	Great Barrier Reef 10°S	Mooloolaba 28°S	S. E. Queensland 0°	Borneo 0°	Philippines 10°N	Tokara Is. 30°N	Okinawa 26°N	Palau Is. 10°N	Eniwetok 10°N	Marshall Is. 10°N	Hawaii 20°N	Gilbert Is. 0°	Line Is. 0°	Fiji 20°S	Tonga 23°S
<i>D. molle</i>	X					X	X	X	X	X						X	X	X					X	
<i>T. cyclops</i>		X	X			X	X	X	X	X								X			X		X	
<i>L. voeltzkowi</i>		X				X	X	X	X	X							X						X	
<i>L. bistratum</i>						X	X	X	X	X	X										X		X	
<i>D. virens</i>			X			X	X	X	X	X													X	
<i>D. similis</i>				X		X	X	X	X	X													X	
<i>L. patellum</i>						X	X	X	X	X													X	
<i>T. clinides</i>						X	X	X	X	X													X	
<i>L. punctatum</i>						X	X	X	X	X													X	
<i>T. paracyclops</i>						X	X	X	X	X													X	
<i>T. nubilum</i>						X	X	X	X	X													X	
<i>T. strigosum</i>						X	X	X	X	X													X	

Remarks: Although the number of branchial folds in this juvenile specimen is less than that recorded for this species, the pointed scale-like siphonal spines are identical with those present in specimens of *M. exasperatus* from the West Indies. These spines distinguish the species from the closely related *M. squamiger* (cup-shaped scales, 0.03 mm) and *M. australis* (longer narrow pointed spines, 0.05 mm) (see Kott and Goodbody, 1981).

Herdmania momus (Savigny, 1816)

Cynthia momus Savigny, 1816, p. 143.

Herdmania momus: Kott, 1972a, p. 41 and synonymy; 1972b, p. 189; 1976, p. 84.

Distribution

New Records: Small specimens of this species occur in cryptic habitats at all locations on the fringing reefs of Viti Levu.

Previously Recorded: This is probably the most commonly occurring ascidian species at all locations over a wide pan-tropical range in the Indian, the Pacific and the Atlantic Oceans. It occurs in the Red Sea, extends into temperate waters around the southern coasts of the Australian and the African continents. It occurs in most tropical Pacific locations including Hawaii.

Description

Small individuals of this species are almost spherical, with short siphons diverging from one another. The specimens are pink and translucent in life but become white in preservative. The barbed spines that occur in the test, the body wall and the branchial sac are characteristic and unique to this monotypic genus.

BIOGEOGRAPHY

Tables 1, 2

Apart from the three species presently recorded only from Fiji*, all but 6 of the species discussed above are also recorded from either the Philippines (20 species), Indonesia (28 species) or northern tropical Australia including the Great Barrier Reef (42 species), and many have been taken at more than one or at all of these locations. The records reflect the intensity of collecting at these locations, but also indicate that for ascidians, the region from Japan in the north to Torres Strait, along the length of the Great Barrier Reef and east to Fiji comprises the west-Pacific marine region. Half of the species extend into the Indian Ocean generally as far as the West Indian Ocean, and of these several also extend further east to Hawaii. This group of 17 species with an extended distribution in the Indo-west Pacific includes five species that are pantropical, occurring in the Atlantic as well as the Indian and Pacific Oceans. It is of interest that those species with the widest longitudinal range have also the widest latitudinal range and of the tropical species are the ones that are found to occur most often in temperate waters. Apart from endemic species, *Pseudodistoma aurea* recorded only from Fiji and the North Island of New Zealand has the most restricted range.

This pattern of distribution suggests that the capacity of the species to maintain gene flow over a wide geographic range affects the pattern of its distribution to a greater extent than environmental factors such as temperature and substrate.

Tokioka (1950, 1955, 1961, 1967) has recorded a total of 72 species from the central-west Pacific, 35 of which have not yet been recorded from Fiji. It should also

* *Eudistoma discederata* n. sp., *E. vitiata*, n. sp. and *Diplosoma multipapillata* Kott.

be noted that there are no representatives of the families Clavelinidae or Diazonidae and a few phlebobranch or stolidobranch species in the present collections from the reef flats. Undoubtedly further collecting at greater depths will disclose that many, if not all, of these species and many others also occur in Fiji. Probably the list of Fijian ascidians will eventually exceed 100 species.

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